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A
SURVEY
OF THE
Wiſdom of GOD *in the* CREATION:
OR A
COMPENDIUM
OF
Natural Philoſophy.

In TWO VOLUMES.

VOL. II.

> Theſe are thy glorious Works, Parent of Good,
> Almighty! Thine this univerſal Frame,
> Thus wondrous fair! Thyſelf how wondrous then!
> MILTON.

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A VIEW OF THE Wiſdom of GOD in the CREATION: OR A COMPENDIUM OF Natural Philoſophy.

Part the Third.

CHAP. III.

Of Metals, Minerals and other Foſſils.

1. *The Variety of Foſſils:*
2. *The general Properties of Metals:*
3. *Of the* Nutrition *and* Generation *of Metals:*
4. *Of Gold, Silver, Copper, Iron, Tin, Lead:.*
5. *Of Steel:*
6. *Of Quickſilver,*
7. *Of Salts,*
8. *Of Stones,*
9. *Of Lime,*
10. *Of precious Stones,*
11. *Of the Loadſtone,*
12. *Of inflammable Foſſils.*

1. AMONG the Bodies that remain to be conſidered, thoſe which ſeem to bear the neareſt reſemblance to Plants are *Foſſils,* comprehending under the name all Bodies that are dug out of the Earth. Theſe have frequently been, for Order's ſake, divided into Three Claſſes, ſuch as are capable of Liquefaction, ſuch as are reducible to a Calx, and ſuch as are inflammable. Of the firſt Claſs are *Metals,* Gold, Silver, Copper, Iron, Tin, Lead, Quickſilver. However theſe differ in other reſpects, they all agree in the following Particulars,

That they are heavier than any other Bodies yet known, that they are malleable, and that they are capable of Liquefaction.

2. It is not improbably ſuppoſed, all Metals conſiſt of Particles ſo heavy, that they cannot be wholly torn aſunder or diſſipated by Fire, or put into ſo rapid a Motion as to inflame. It only ſeparates them ſo far as not to reſiſt a hard Body, which is what we term Liquefaction. Their *Malleableneſs*, or bearing to be wrought by the Hammer, may ſpring from the Figure of their Parts, perhaps oblong or Square, which may occaſion their cohering ſo ſtrongly, as not eaſily to be ſeparated. And it is probable the Pores either of their conſtituent Particles, or of the whole Maſs are few and ſmall; which may account for their being ſo much heavier than any other known Bodies.

This is the radical Character of Metals. The Weight of Gold to that of Glaſs is as Nine to One. And the Weight of Tin, the lighteſt of all Metals, is to that of Gold, as 7 to 19: which conſiderably ſurpaſſes the Weight of all Stones and other the moſt ſolid Bodies. Nor is there any Body in nature but a Metal, that is one Third of the weight of Gold.

The ſpecific Weight of the ſeveral Metals, and of Granate, Water and Air, ſtands thus:

Gold	19636	Iron	7852
Quickſilver	14019	Tin	7321
Lead	11345	Granate	3978
Silver	10535	Water	1000
Copper	·8843	Air	$\frac{3}{11}$

3. The *Nutrition* of Metals ſeems to conſiſt only in the accretion of homogeneous Parts, which is not improbably ſuppoſed to continue, while they lie in their native Bed. Many ſuppoſe, they have lain there, ever ſince the Flood, if not ever ſince the Creation. Whether they have or not, they ſeem to grow, as long as they remain therein. And after theſe Beds have been emptied by Miners, in a time they recruit again. Yea, the Earth or Ore of *Alum* will recruit above-ground, if it be expoſed to the open Air. And ſo in the Foreſt of *Deane* the beſt Iron, and in the greateſt Quantities is found in the old Cinders melted over again.

HOWEVER it has been long diſputed, Whether Metals are *generated*, or were all originally produced at the Creation: And whether there be any General *Seed* of Metals, as ſome ſuppoſe *Antimony* to be. This is indeed a Foſſile of a very peculiar Nature. It is a kind of undetermined metallic Subſtance, mixt with ſtony and ſulphureous Particles, ſo that 'tis hard to reduce it to any Claſs. It is found in Mines of all Metals, but chiefly in Silver or Lead-mines: That in Gold-mines is counted the beſt. It has alſo its own peculiar Mines: It lies in Clods of ſeveral ſizes, nearly reſembling Black-lead, but is full of ſmall, ſhining Threads, like Needles, brittle as Glaſs. It melts in the fire, tho' with ſome difficulty. Its uſes are very numerous. It is a Medicine of ſovereign Uſe in many Caſes, when warily and properly adminiſtered. It is a common Ingredient in burning Concaves, ſerving to give the compoſition a finer Texture. It makes a part in Bell-metal, in order to render the ſound more clear. It is mingled with Tin, to make it more hard, as well as of a brighter Colour, and with Lead, in caſting of Printer's Letters, to render them more ſmooth and firm. It is alſo a general help in the caſting of Metals, and eſpecially, in caſting Cannon-balls.

4. THE chief Properties of *Gold* are, 1. It is the heavieſt, tho' not the hardeſt, of Bodies. And in every maſs of matter heavier than Mercury, there muſt be a ſhare of Gold; there being no Body diſcovered in the Univerſe of intermediate Gravity; none whoſe Gravity is to that of Gold more than as fourteen to nineteen. 2. It is the moſt ductile and malleable of all Metals, of which Gold-beaters and Wire-drawers give us an abundant Proof. But this depends altogether (incomprehenſible as it is) on its being free from Sulphur. For mix but one grain of Sulphur with a thouſand of Gold, and it is malleable no longer. 3 It is more fixt in the Fire than any other Metal. Lay a quantity of Gold two months in the intenſeſt Heat, and when it is taken out, there is no ſenſible Diminution of its Weight. And yet in the Focus of a large Burning-glaſs, it volatilizes and evaporates. Yea, many thouſands of Moidores were wholly conſumed, others half, or a quarter conſumed,

by the Flames which broke out of the Earth, during the late Earthquake at *Liſbon*. Gold may likewiſe by a Glaſs be fuſed into a ſort of Calx, and then vitrified. But if the ſame be fuſed again with Greaſe, it is reſtored into Gold. 4. It is diſſolvible by no Menſtruum known, but *Aqua Regia* and Mercury. The Baſis of Aqua Regia is Sea-ſalt, the only Salt which has any effect on Gold. But this has its effect however applied, whether in a fluid or ſolid form. 5. It readily and ſpontaneouſly attracts, and abſorbs Mercury. But as ſoon as the Mercury enters it, the Gold becomes ſoft like Paſte. 6 It withſtands the violence both of Lead and Antimony. All Metals but Gold and Silver, melted with Lead, periſh with it and evaporate; and all but Gold, if melted with Antimony. Thus melt Gold, Silver, Copper and Tin with Antimony, and all the reſt riſe to the top, and are blown off with bellows, but the Gold remains behind. Hence Antimony is uſed as the Teſt of Gold.

THE Malleableneſs or Ductility of Gold, is beyond all Imagination. By exact weighing and computation it has been found, that there are Gold-leaves, which in ſome parts of them are ſcarce the 360000th part of an inch thick. And yet this is a notable thickneſs in compariſon of that of the Gold ſpun on Silk in Gold-thread. It has been proved, that the Breadth of theſe Gold-Plates is only the 96th Part of an inch, and their thickneſs, the the 3072d: So that an ounce of Gold is here extended to a Surface of 1190 ſquare feet.

How thin muſt it be when thus extended! In ſome Parts, it has been computed, its thickneſs is only the 315000th Part of an inch! And yet with this amazing Thinneſs, it is ſtill a perfect Cover for the Silver: Nor can the beſt Eye, or even the beſt Microſcope diſcern the leaſt Chaſm or Diſcontinuity. Nay, there is not an Aperture to admit Alcohol of Wine, one of the ſubtleſt Fluids in nature: No, nor Light itſelf. So cloſely connected are the Particles, notwithſtanding their inconceivable Thinneſs.

Silver approaches neareſt to Gold, both in Weight, in Ductility, and in reſiſting Fire. *Copper* comes next to Silver in theſe Properties. *Braſs* is an artificial Metal, compoſed of Copper fuſed with Lapis Calaminaris. *Iron* is leſs ductile than any of theſe and contains more Droſs. [a] It likewiſe eaſily ruſts, whereas Silver ſeldom ruſts, and Gold ſeldom either ruſts or cankers. *Tin* reſembles [b] Lead, but is conſiderably harder, and not near ſo heavy. Indeed it ſeems to be a ſort of imperfect Metal, generated of two different Seeds, that of Silver, and that of Lead, which makes it a kind of Compound of both. And it is ſometimes found in Silver Mines, ſometimes in Lead-mines, tho' it has alſo Mines of its own. It is the lighteſt of all Metals, very little ductile or elaſtic, but the moſt fuſible of all. It is ſcarce diſſolvible with Acids, but eaſily mixes with other Metals.

5. If Iron in melting be carefully purged from its Droſs, drawn into Plates, and plunged red-hot into cold Water, it grows harder, and is termed *Steel.* But it is conſiderably ſoftened again, if it is put into the Fire, and afterward left to cool gradually in the Air.

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[a] The *Arbor Martis* is a Germination of Iron, reſembling a natural Plant. The Manner of its Diſcovery was this. One poured Oil of Tartar on Iron Filings, diſſolved in Spirit of Nitre in a Glaſs. Preſently the Liquor ſwelled much, tho' with little Fermentation, and was no ſooner at reſt, than there aroſe a ſort of Branches adhering to the Glaſs, which increaſed 'till they covered it all over. And theſe Branches were ſo perfect, that one might even diſcover a kind of Leaves and Flowers thereon. The Experiment has ſince been frequently repeated, and with the ſame Succeſs.

The Spirit of Vitriol, being mixt with Iron, after fermenting, produces a green Vitriol like the Natural one. But if for Spirit of Vitriol, you uſe Oil of Vitriol, which is the moſt acid Part of that Mineral, there happens immediately a ſmall fermentation, which is quickly over. That fermentation begins again in a few days, under the form of a white Smoke, which riſes to the Surface, and the whole maſs of Iron turns into a very white pap which ſmells like common Sulphur. When the fermentation is over, the Iron, inſtead of turning into green Vitriol, becomes on a ſudden white Vitriol. Meantime there is on its ſurface a black Duſt, which it has thrown up. It ſeems, this would have made it green. For if white Vitriol be mingled with this Duſt, it acquires a green Colour.

[b] *White Lead* is thin Plates of Lead diſſolved in Vinegar.

Red Lead is common Lead calcined.

Black Lead (very improperly ſo called) is only a talky kind of Earth.

6. *Quickſilver* differs from all Metals, in that it is naturally liquid. Its Properties are 1. It is the heavieſt of all Bodies, but Gold. 2. It is the moſt fluid of all. The Particles even of Water, do not divide ſo eaſily as thoſe of Quickſilver: they have hardly any Coheſion. 3. Of all Bodies it is diviſible into the minuteſt Parts. Being on the fire, it reſolves into an almoſt inviſible Vapour. But let it be divided ever ſo much, it ſtill retains its Nature. For the Vapours of diſtilled Quickſilver, received in Water or on moiſt Leather, become pure Quickſilver. And if it be mixt with Lead or other Bodies, in order to be fixt, it is eaſily by fire ſeparated from them again, and reduced to its antient Form. 4. It is extremely volatile, being convertible into a Fume, even in a Sand-heat. 5. Of all Fluids it is in equal Circumſtances the coldeſt and the hotteſt. This depends on its Weight; for the Heat and Cold of all Bodies, is (cæteris paribus) as their Weight. 6. It is diſſolvible by almoſt all Acids, but Vinegar. And hereby we diſcover, if it be ſophiſticated with Lead. Rub it in a Mortar with Vinegar. If it be mixt with Lead, it grows ſweetiſh; if with Copper, it turns greeniſh or bluiſh. If there be no Adulteration, the Quickſilver and Vinegar will both remain as before. 7. It is the moſt ſimple of all Bodies, but Gold. 8 It has no Acidity at all, nor does it corrode any Body.

But it may be obſerved of Metals in general, there is great Uncertainty and Inconſtancy in the Metallic and Mineral Kingdoms, both as to Colour, Figure and Situation. A Marcaſite, for inſtance, may have the Colour of Gold and Silver, and yet afford nothing but a little Vitriol and Sulphur: While what is only a Pebble in appearance, may contain real Gold.

It is common alſo to find the ſame Metal ſhot into many different Forms, as well as to find different kinds of Metal of the ſame Form. There is the ſame Uncertainty as to their Place. Sometimes they are found in the perpendicular Fiſſures of the Strata, ſometimes interſperſed in the Subſtance of them; and the ſame Metals in Strata of very different Natures. They are likewiſe frequently intermixt with each other; ſo that we ſeldom find any of them pure and ſimple, but Copper and Iron, Gold and Copper, Silver and Lead, Tin and Lead, in one Maſs: Yea, ſometimes all ſix together.

WHAT diſtinguiſhes them from all other Bodies, as well as from each other, is their Heavineſs: Each Metal having its peculiar Weight, which no Art can imitate.

BUT who can reckon the various Ways, wherein Metals are uſeful to Mankind? Without theſe we could have nothing of Culture or Civility: No Tillage, or Agriculture; no reaping or mowing, no plowing or digging, no pruning or grafting, no Mechanic Arts or Trades, no Veſſels or Utenſils of Houſhold-ſtuff, no convenient Houſes or Edifices, no Shipping or Navigation. What a barbarous and ſordid Life, we muſt neceſſarily have lived, the *Indians* in the Northern Parts of *America*, are a clear Demonſtration.

AND it is remarkable, that thoſe which are of moſt neceſſary uſe, as Iron and Lead, are the moſt plentiful. Thoſe which may better be ſpared, are more rare. And by this very circumſtance they are qualified, to be made the common meaſure and Standard of the Value of other Commodities, and ſo ſerve for Money, to which uſe they have been employed by all civil Nations in all Ages.

ALL Metals are liable to *Ruſt*. Gold itſelf ruſts, if expoſed to the Fumes of Sea-ſalt. The great Inſtrument in producing Ruſt is Water: Air, only by the Water it contains. Hence in dry Air Metals do not ruſt: Neither if they are well oiled: Water not being able to penetrate Oil. Ruſt is only, the Metal under another Form: Accordingly Ruſt of Copper may be turned into Copper again. Iron if not preſerved from the Air by Paint, will in time turn wholly into Ruſt.

7. To the Second Claſs of Foſſils belong thoſe which are reduced by Fire to a Calx. Such are 1. *Salts*, all Foſſils which (whether they have a ſalt taſte or no) are ſoluble in Water. *Common Salt* is heavier than Water, and if quite pure, melts when left in the

open Air. If the Water it is diſſolved in be boiled and evaporated, it remains in the bottom of the Veſſel. It is well known to preſerve Fleſh from Putrefaction, and to be very difficultly diſſolved by Fire. Probably it is compoſed of pointed Particles, which fix in the pores of Fleſh, and by reaſon of their Figure are eaſily divided by Water, tho' not by Fire. It ever comes purer out of the Fire. Yet it will fuſe in a very intenſe Heat.

ALL Salt diſſolves by Moiſture: but it only diſſolves a certain Quantity. Yet when it is impregnated with any Salt, as much as it can bear, it will ſtill diſſolve a conſiderable Quantity of another kind of Salt. It ſeems, the Particles of this, being of different Figures, inſinuate into the remaining Vacuities. Thus when a Cup of Water will diſſolve no more Common Salt, Alum will diſſolve in it. And when it will diſſolve no more Alum, Saltpetre will diſſolve, and after that, Sal Ammoniac.

THE moſt remarkable Salt-mines in the World, are in the village *Williſca*, five Leagues from *Cracow* in *Poland*. They were firſt diſcovered above 500 years ago, in the year 1251. Their Depth and Capacity are ſurprizing. They contain a kind of ſubterranean Republic, which has its Laws, Polity, Carriages, and Public Roads, for the Horſes which are kept there, to draw the Salt to the mouth of the Quarry. Theſe Horſes after once they are down, never ſee the Light of the Day again. But the men take frequent Occaſions, of breathing the upper Air. When a Stranger comes to the bottom of this Abyſs, where ſo many People are interred alive, and where ſo many were born, and have never ſtirred out, he is ſurprized with a long ſeries of lofty Vaults, ſuſtained by huge Pillars, which being all Rock-Salt, appear by the Light of Flambeaux that are continually burning, as ſo many Chryſtals, or precious Stones of various Colours.

8. To this Claſs, Secondly, belong *Stones*, which are hard, rigid, void of Taſte, reducible to Duſt by the Hammer, and into a Calx by Fire. It is probable, that Stones, like Salts and moſt Foſſils, are *generated* from a

Fluid, which gradually hardens into Stone, by the Evaporation of its finer Parts.

Mr. *Tournefort* obſerved, That in the famous Labyrinth of *Crete*, ſeveral Perſons had engraved their Names in the living Rock, of which its Walls are formed: And that the Letters ſo engraven, inſtead of being hollow, as they were at firſt, ſtood out from the Surface of the Rock. This can no otherwiſe be accounted for, than by ſuppoſing the Cavities of the Letters filled inſenſibly, with Matter iſſuing from the Subſtance of the Rock, even in more abundance than was needful to fill thoſe Cavities. Thus is the Wound of a Knife healed up, much as the Fracture of a Bone is conſolidated, by a Callus formed of the extravaſated nutritious Juice, which riſes above the Surface of the Bone. Such Callus's have been obſerved to be formed on other Stones, which were reunited after they had been accidentally broken. Hence it is manifeſt, That Stones grow in the Quarries, and conſequently are fed; and that the ſame Juice, which nouriſhes them ſerves, to rejoin their Parts when broken. There is then no room to doubt, that they are organized, and draw their nutritious Juice from the Earth, which is firſt filtrated and prepared in the Surface of the Stone, and thence conveyed to all the other Parts.

Doubtless the Juice which filled the Cavities of thoſe Letters was brought thither from the root of the Rock, which grew as Corals do (tho' they are juſt as hard in the Sea, as out of it) or Sea-Muſhrooms, which every one allows to grow: And yet they are true Stones.

Indeed there are ſome Species of Stones, whoſe Generation can no otherwiſe be accounted for, than by ſuppoſing, them to come from a kind of Seeds, which contain its origanized Parts in Miniature. But many ſorts of Stones were once fluid; witneſs the various foreign Bodies found therein.

That even Pebble Stones grow, may be proved to a demonſtration, by an eaſy Experiment. Weigh a Quantity of Pebbles and bury them in the Earth. After a time dig them up. And on weighing them again, you will find they have gained a very conſiderable Addition.

Many Waters are generally ſuppoſed to turn other Bodies into Stone. This is aſcribed to the Lake *Loghmond*

mond in *Scotland*, and *Lough Neagh* in *Ireland*. But it is a miſtake. There is not in reality any ſuch Tranſmutation in thoſe Bodies. Only the ſtony Particles floating in the Water, lodge in the Pores, or on the Surface of them. Petrefactions therefore are nothing more than Incruſtations of ſtony Particles, which ſurround and partly inſinuate into the Bodies immerſed.

9. FROM Stone burnt to Duſt ariſes *Lime*, which has this remarkable Property, that if Cold Water be poured upon it, it preſently heats and boils up. In order to account for this, ſome have ſuppoſed, that ſome ſubtle Matter is lodged in the Pores of the Lime (perhaps many of thoſe Particles of Fire, whereby the Stone was reduced to Duſt) which when the Water inſinuates into thoſe Pores, occaſions the ſame kind of Ebullition, as if it was poured on any other burning Subſtance.

10. Moſt *precious* Stones are tranſparent and ſtrike the eye with vivid and various Colours. Probably they were once fluid Bodies, which while in that State were mixt with Metallic or Mineral Juices. Their Tranſparency likewiſe makes this probable, and ſo does their outward Configuration. For many Bodies hardening into Solids, ſhoot into Chryſtals,[c] juſt as is obſerved of ſeve-

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[c] DR. *Boerhaave* takes *Chryſtal* to be the Baſis of all precious Stones, which aſſume this or that Colour, from the Metallic or Mineral Streams mixt with the primitive Chryſtalline Matter. But how is Chryſtal itſelf formed? An *Italian* Writer gives a particular account of this. In the *Val Sabbia* (ſays he) I obſerved ſome Parts of a Meadow bare of all Herbs. Here, and no where elſe thereabouts, the Chryſtals are generated. And whenever there is a ſerene and dewy Sky, if all the Chryſtals that can be found over night, are taken away, others will be found in the ſame place in the Morning. Having obſerved, there is no Sign of any Mineral Stream near, I conclude, they are produced by Steams of Nitre. Theſe may at the ſame time hinder Vegetation in thoſe places, and coagulate the Dew that falls thereon. As Nitre is the Natural Coagulum of Water, ſo it ever retains its ſexangular Figure. The largeſt Chryſtals known were found in the Mountains of *Grimſule*, between vaſt Strata of Stones. The biggeſt of them was near three feet in length, and little leſs in Circumference. It weighed two hundred and fifty Pounds; others weighed leſs and leſs, to thoſe of ten pounds, which were the ſmalleſt there. They were of the ſame

ral kinds of precious Stones. And to this their inward Structure anſwers. For in many we may obſerve the thin plates or coats one over the other, juſt as we ſee in thoſe Mineral Subſtances, which were once fluid. Their Colours might be owing to ſome Mineral Juice or Exhalation, which tinctured them before their Pores were fully cloſed. This is the more probable, becauſe many Gems loſe their Colour, if they lie long in the Fire: And becauſe generally coloured Gems are found over Metallic or Mineral Veins.

A VERY peculiar kind of precious Stone, is what is termed a *Turquois*. It is of the opake kind, and of a beautiful blue colour. And yet it has lately been made very probable, that theſe ſhining ſtones are originally no other than the Bones of Animals. In the *French* Mines they are frequently found in the figure of Teeth, Bones of the Legs, &c. And Turquoiſes half formed are compoſed of Laminæ, like thoſe of Bones, between which a petrifying Juice inſinuating, binds them cloſe together. And the more imperfect the Stones are, the more diſtinguiſhable are the different Directions, of the Fibres and their Laminæ, and the nearer Reſemblance they bear to fractured Bones.

11. THE *Loadſtone* is found in Iron-mines, and reſembles Iron both in Weight and Colour. Its moſt remarkable Properties are, Turning to the Poles, and attracting Iron. As to the former, when it moves without Hindrance, it conſtantly turns one End to the North, the other to the South: only declining a little to the Eaſt or Weſt. If two Loadſtones are brought within a certain

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Figure; Sexangular Columns, terminated by Sexangular Pyramids at one end, and at the other fixt to the Rock. They were in general perfectly clear throughout, but in ſome the Baſe was foul, in others the Point.

IF a Solution of *Alum* is permitted to chryſtalize quietly, it ſhoots into planes of eight, ſix, four and three ſides. But beſide this, its Particles when excited to action by a certain degree of Heat, arrange themſelves into regular and delightful ſtar-like figures of different Sizes. Many of theſe have long ſtreaming Tails, and reſemble Comets. Others ſhoot into an infinite number of parallel Lines, beautiful beyond deſcription. Theſe Configurations are no leſs con-

Diſtance of each other, that part of one which is toward the North Pole of the Earth, recedes from that Part of the other which reſpects the ſame Pole. But it accedes to it, if the ſouthern Pole of the one, be turned toward the ſouth Pole of the other. The Needle touched with the Loadſtone, when on this ſide the Equinoctial Line, has its North-point bending downward, on the other ſide, its South-point: Under the Line, it turns any way, and is of no uſe.

As to its Attractive Power, it not only ſuſtains another Loadſtone, (provided the North Pole of the one be oppoſed to the South Pole of the other) but Iron alſo. Likewiſe if Steel-duſt be laid upon a Loadſtone, it will ſo diſpoſe itſelf, as to direct its Particles ſtrait to the Poles, whence they will be moved round by little and little, 'till they are parallel to the Axis of the Loadſtone. It communicates its virtue to Iron, and if it be *armed* (that is, fixt in) Iron, its force is greatly increaſed. It loſes its force either by Fire, or by letting two Loadſtones lie together, with the North-Pole of one oppoſed to the North, or the South-Pole of one to the South of the other. Theſe plain Phœnomena of the Loadſtone we know: The Cauſe of them we know not.

FROM late Obſervations it appears, that the Loadſtone is a true Iron Ore, and is ſometimes found in very large pieces, half Loadſtone, half common Ore. In every one 1. There are two Poles, one pointing North, the other South. And if it be divided into ever ſo many pieces, the two Poles will be found in each Piece. 2. If two Loadſtones be ſpherical, one will conform itſelf to the other, as either would do to the Earth, and will then approach each other: whereas in the contrary Poſition, they

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ſtant in their forms, than the Chryſtals on which they grow. And they are equally tranſparent, but the Figures produced are ſo extremely different, that every conſiderate Obſerver muſt judge them to be owing to ſome very different Property in nature. But what Property? Who can determine? Indeed how little do we know of the moſt common things? The very Elements that ſurround us, the Fire, the Water, the Air we breathe, the Earth we tread upon, have many Properties beyond our Senſes to reach, or our Underſtanding to comprehend.

they recede from each other. 3. Iron receives virtue, either by touching, or by being brought near the Stone: And that variouſly, according to the various Parts of it which it touches. 4. The longer the Iron touches the Stone, the longer it retains the Virtue. 5. Steel receives this Virtue better than Iron. 6. In theſe Parts the South Pole of a Loadſtone lifts more Iron than the North Pole. 7. A Plate of Iron interpoſed hinders the Operation of the Loadſtone; but no other Body, no not Glaſs itſelf. 8. A touched Wire, if bent round in a ring, quite loſes its Virtue. But tho' bending thus, deſtroys its Virtue by day, it will not deſtroy it in the Evening. Where is the Philoſopher in the world, who can account for this? 9. Loadſtones without any known cauſe, act ſometimes at a greater diſtance than other times. That of the Royal Society will keep a Key ſuſpended to another, ſometimes at the height of Ten feet, ſometimes not above Four. As ſtrange it is, that the Variation of the Needle is different at different times of the Day. 10. If a touched Wire be ſplit, the Poles are ſometimes changed (as in a ſplit Loadſtone). And yet ſometimes one half retains the ſame Poles, and the other half has them changed. 11. Touch a Wire from end to end with the ſame Pole of the Loadſtone, and the End firſt touched turns contrary to the Pole that touched it. But touch it again from end to end with the other Pole of the Stone, and it will turn juſt the contrary way. 12. Touch a Wire in the middle with one Pole of the Stone, and the Pole of the Wire will be in that place: the two Ends will be the other Pole. 13. The Poles of a ſmall Loadſtone may preſently be changed, by applying them to the oppoſite Poles of a large one. 14. Iron Bars which ſtand long in an erect Poſition, grow permanently magnetical; the lower End of them being the North Pole, and the upper the South Pole. 15. The ſame effect follows, if you only hold them perpendicularly: But if you invert them, the Poles will ſhift their places. 16. Fire, which deprives a Loadſtone of its attractive virtue, ſoon gives Verticity to a Bar of Iron, if it be heated red hot, and then cooled in an erect Poſture, or directly North and South. 17. A piece of *Engliſh* Oker, thus heated and cooled, acquires the ſame Verticity. 18. The Verticity thus acquired by a Bar of Iron, is deſtroyed by two or three ſmart Blows on the middle of it. 19. Either a piece of Iron or a Loadſtone being laid on a cork that ſwims freely in the Water, which ever of the two is held in the hand, the other will be drawn to it. This proves that the Iron attracts the Stone, juſt as much as it is attracted by it. 20. Draw a Knife leiſurely from the handle to the point over one of the Poles of a Loadſtone, and it acquires a ſtrong, magnetic Virtue. But this is immediately loſt, if you draw it over the ſame Pole, from the Point to the Handle. Laſtly, A Loadſtone acts with as great force in vacuo, as in the open Air.

THE chief Laws of Magnetiſm are theſe, 1. The Loadſtone has both an Attractive and a Directive Power: Iron touched by it has only the former: 2. Iron ſeems to conſiſt almoſt wholly of attractive Particles, Loadſtones of attractive and directive together, probably mixt with heterogeneous matter, as not having been purged by Fire, like Iron. And hence Iron, when touched, will lift up a much greater Weight than the Loadſtone that touched it. 3. The attractive Power of armed Loadſtones, is *cæteris paribus*, as their Surfaces. 4. Both Poles of the Loadſtone equally attract the Needle 'till it is touched. Then it is that one Pole begins to attract one End and repel the other. But even the repelling Pole will attract upon Contact, or at a very ſmall Diſtance.

BEFORE cloſing this Article, it may be proper to obſerve, firſt, The peculiar *Qualities* wherewith ſome other Stones are endued, and Secondly, The emarkably *Uſes* they are of to us. As to the former, we may obſerve 1. The *Colour*. The *Carbuncle* and *Ruby* ſhine with Red, the *Sapphire* with blue, the *Emerald* with green, the *Topaz* with a yellow or Gold-colour; the *Amethyſt*, is as it were tinctured with Wine, the *Opal* varies its Colour like changeable Taffeta as it is variouſly expoſed to the Light. Obſerve 2. The *Hardneſs*, wherein ſome Stones exceed all other Bodies, the *Diamond* in particular, which is ſo extremely hard, that no Art is able to counterfeit it. As to the Uſes, Some are ſerviceable for Building, and for many ſorts of Veſſels and Utenſils; for Pillars and

Statues; for Portico's, Conduits, Palaces, as *Free-ſtone* and *Marble:* Some, to burn into Lime, ſome (with the mixture of Kelp) to make Glaſs, as common *Flints:* Some to cover Houſes, as *Slate*; ſome for marking, as *Chalk*, which ſerves alſo to manure Land, and for Medicinal Uſes: Some to make Veſſels which will endure the Fire. I might add the Warming-Stone digged in *Cornwall:* which being once well heated at the Fire, retains its Heat for a conſiderable time.

12. Of the Third Claſs are *Inflammable* Foſſils, the chief of which are *Sulphur* and *Bitumen.* Both are highly inflammable: But the Subſtance of Bitumen is more fat and tenacious; whereas Sulphur may eaſily be broken, and reduced to a fine Powder.

The Bitumen of the *Latins* was by the *Greeks* called *Aſphaltos.* It is a black, ſolid, brittle Subſtance, reſembling Pitch. It is chiefly found ſwimming on the *Dead Sea*, where antiently ſtood *Sodom* and *Gomorrah.* It is caſt up from time to time from the bottom to the Surface, where it gradually condenſes by the heat of the Sun. It burns as violently as Naphtha; but is of a firmer conſiſtence.

Aſphaltos is alſo a kind of bituminous Stone, found near the antient *Babylon*, and lately in the Province of *Neufchatel*, which properly mixt makes an excellent Cement, incorruptible either by Air or Water. With this, it is ſuppoſed, the Walls of *Babylon* were built.

Jet ſeems to be formed in the Earth of a bituminous Juice. It is a light, ſmooth, pitchy Stone. It is fiſſile and works like Amber: the beſt in the world is ſaid to be found in *Yorkſhire.* It readily catches fire, flaſhes and yields a bituminous Smell. Nearly reſembling this is the *Channel-Coal*, found in ſeveral Parts of *Lancaſhire*, which burns with an even, ſteddy flame, like a Candle or Torch.

But the moſt extraordinary of all Foſſils is the *Aſbeſtos.* It ſeems to be a ſpecies of Alabaſter, and may be drawn into fine ſilky threads, of a greyiſh or ſilver colour. It is indiſſoluble in Water, and remains unconſumed even in the Flame of a Furnace. A large Burning-glaſs indeed will reduce it to Glaſs Globules; but common Fire only whitens it. Its threads are from One to Ten Inches long, which may be wrought into a kind of Cloth. This the Antients eſteemed as precious as Pearls. They uſed it chiefly in making Shrouds, for Emperors or Kings, to preſerve their Aſhes diſtinct from that of the Funeral Pile. And the Princes of *Tartary* at this day apply it to the ſame uſe. The Wicks for their perpetual Lamps were likewiſe made of it. A Handkerchief of this was long ſince preſented to the Royal Society. It was twice thrown into a ſtrong Fire, before ſeveral Gentlemen. But in the two Experiments it loſt above two Drams of its weight. And what was very remarkable, when it was red-hot, it did not burn a piece of white Paper, on which it was laid.

But there is a kind of *Aſbeſtos*, wholly different from that known to the Antients. It is found, ſo far as we yet know, only in the County of *Aberdeen* in *Scotland*. In the neighbourhood of *Achintore*, on the ſide of an Hill, in a ſomewhat boggy Soil, about the Edges of a ſmall Brook, there is a Space ten or twelve yards ſquare, in which elegant pieces of Foſſile Wood petrified lie very thick. Near this Place, if the Ground be dug into with a Knife, there is found a ſort of fibrous matter, lying a little below the ſurface of the Ground, among the Roots of the Graſs. This the Knife will not cut; and on examination it proves to be a true Aſbeſtos. It lies in looſe Threads, very ſoft and flexible, and is not injured by the Fire.

Yet it is ſometimes collected into Parcels, and ſeems to form a compact Body. When this however is more nearly examined, it appears not to be a real Lump, but a congeries reſembling a Pledgit of preſſed Lint, and being put into water, it ſeparates into its natural looſe Threads.

But a ſtranger Diſcovery ſtill has been lately made. The Proprietor of a Forge, upon taking down his Furnaces to repair them, found at the bottom a great Quantity of a Subſtance, which upon repeated trial, effectually anſwered all the uſes of the Aſbeſtos. It was equally well manufactured either into Linen or Paper, and equally well endured the Fire. Upon proſecuting the

Enquiry, it appeared to Him, That both the native Aſbeſtos (at leaſt one Species of it) and this obtained from the Forge, were nothing more, than what he terms *calcined Iron*, deprived, whether by Nature or by Art, of its inflammable Part: And that by uniting the inflammable Part either with this, or the foſſil Aſbeſtos, it may at any time be reſtored, to its primitive State of Iron.

But it is certain, there is Aſbeſtos which has no relation to Iron. Both in *Norway* and *Siberia*, there are petrifying Waters which pervade the Pores of Wood lying therein, fill it with ſtony Particles; and when by a cauſtic, corroſive Power, derived from Lime, they have deſtroyed the Wood, a proper Aſbeſtos remains, in the form of the Vegetable which is now no more.

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Part the Fourth.

Of Earth, Water, Fire, Air *and* Meteors.

CHAP. I.

Of Earth and Water.

1. *Of the Formation of the Earth:*
2. *Of Mountains:*
3. *The Properties of Water:*
4. *Of Ice:*
5. *The Origin of Fountains:*
6. *Of the Sea:*
7. *Of the Baſon of the Sea:*
8. *Of the Tides:*
9. *Of Currents in the Sea.*

1. THE *Earth* or Terraqueous Globe is a Congeries of many different Bodies. It contains Sand, Clay, various Sorts of Earth, Stones, Salts of various kinds, Sulphur, Bitumen, Metals, Minerals, and other Foſſils almoſt innumerable. Upon the Earth are the Waters, and on or near its Surface, Animals and Vegetables of all kinds. But how was this whole Maſs formed into Mountains, Valleys, Seas, Rivers, Iſlands:

Iſlands? *Des Cartes* advances one Hypotheſis, Dr. *Burnet* another, Mr. *Hutchinſon* a Third. And each World-builder advances plauſible Reaſons for his own Hypotheſis. But none of thoſe Reaſons are demonſtrative: higher than Probability they cannot go.

THAT the Earth is round, manifeſtly appears from the Eclipſes of the Moon, in all which the Shadow appears circular, which way ſoever it be projected. The Natural Cauſe of its Roundneſs, is the great Principle of Attraction, which the Creator has ſtamped on all the Matter of the Univerſe, whereby all Bodies and all the Parts of Bodies continually attract each other. By this means, as all the Parts of Bodies tend naturally to their Center, ſo they take a globous Figure, unleſs ſome other more prevalent Cauſe interpoſe. Hence Drops of Quickſilver put on a Spherical form the Parts ſtrongly attracting each other. Drops of Water have the ſame form, when falling in the Air, but are only half round, when they lie on a hard Body, becauſe their Gravity overpowers their Attraction. Yet the Earth is not exactly round, but ſwells out toward the Equator, and is flatter toward the Poles, which is ſuppoſed to be occaſioned by the Diurnal Rotation of the Earth on its Axis. By this means, the greater Diameter exceeds the leſs, about 34 Miles. What the Earth loſes of its Sphericity by Mountains and Vales is nothing conſiderable: The higheſt Eminence being ſcarce equivalent to the ſmalleſt protuberance on the Surface of an Orange. The Diameter of the Earth is ſuppoſed to be 7967 Miles.

IN the terraqueous Globe are 1. The External Part from which Vegetables grow and Animals are nouriſhed: 2. The Middle Part, which is poſſeſt by Foſſils, and extends farther than human Labour can penetrate: 3. The Internal, which ſome ſuppoſe to be a great Loadſtone; ſome a large Maſs of Fire; ſome a Collection of Waters; and others, an hollow Space inhabited by Animals, which have their Sun, Moon and all other Conveniencies, peculiar to themſelves.

In the External Part we meet with various *Strata*, which were doubtleſs formed by the General Deluge. All earthly Bodies were then diſſolved, and mixt with the Waters in one common Maſs. Afterward they ſunk, nearly according to the Laws of Gravity, the heavieſt firſt, and the lighter in their order. So were theſe Strata formed, which hardening by Degrees, have continued ever ſince. It is probable, theſe lay more regularly at firſt, but have been much Changed in proceſs of Time, and their Order diſturbed by Earthquakes, Vulcano's and divers other Cauſes.

The Earth is nearer the Sun at Chriſtmas than at Midſummer, as appears both from the Sun's Apparent Diameter being greater in December than in June, and from its Motion being then ſwifter. Hence it is that there are about Eight Days more in the Summer half Year from March to September, than in the Winter Half Year from September to March.

That the Earth moves round its own Axis, not the Sun and Stars round the Earth, may appear from this ſingle Conſideration. All the Planets revolve in more or leſs Time, as their Orbits are greater or leſs. If then they moved round the Earth, they muſt revolve in unequal times, according to their Orbits ; not all in the ſame time, in four and twenty Hours, as they ſeem to do. Therefore they do not move round the Earth, but the Earth, as the reſt, round its own Axis.

That it moves alſo round the Sun, appears thus. All Bodies, which turn round each other, muſt gravitate toward each other : Conſequently if the Sun gravitates to the Earth, ſo muſt the Earth to the Sun. Again, it is demonſtrable, that when two Bodies gravitate to each other, without approaching each other in right Lines, they both turn round their common Center of Gravity. But the Earth being no more than a Point to the Sun, the Common Center of theſe two Bodies, will be within the Body of the Sun itſelf, and not far from the Center of it. The Earth therefore turns round a point which is in the Sun : Conſequently round the Sun. Indeed to ſuppoſe the Earth at reſt, deſtroys all the Order and Harmony of the Univerſe, annulls its Laws, and ſets every Part at variance with the others. It renders the Motions of the Planets utterly inexplicable, which are otherwiſe plain and ſimple.

NOR is the Motion of the Earth, whatever is vulgarly ſuppoſed, contrary to any Part of the Scripture. No other Ideas are to be affixt to the words of Scripture, than ſuch as occur to one who looks at the thing ſpoken of. By the Sun's *Riſing* therefore when mentioned in Scripture, we are to underſtand no more, than the Sun's appearing again in the Horizon, after he had been hid below it: And by his *Setting*, his ceaſing to appear. And when the Sun and Moon are ſaid to *ſtand ſtill*, it means only, that they did not change their Situation in reſpect of the Earth: that the Sun ſtill appeared juſt *over Gibeon*, and the Moon *over the Valley of Ajalon.* If it be ſaid, "But *David* ſpeaks of the *Sun running its courſe*," we may anſwer over and above, the Word here uſed does not mean the *Orb* or *Body* of the Sun, but always his *Rays* or *Beams*.

2. ONE of the moſt conſiderable Parts of the Earth is the *Mountains*. There is a remarkable Irregularity in their Figure, and (ſo far as we can judge) an entire Neglect of Order in their Situation. The far greater Part of them are hollow, and contain Beds of Stone, Metals or Minerals. And doubtleſs ſuch they were from the Creation, altho' perhaps not ſo high, ſteep or rugged.

FOR theſe vaſt Maſſes are not, as ſome have Suppoſed, mere Incumbrances of the Creation; rude and uſeleſs Excreſcences of the Globe; but anſwer many excellent Purpoſes. They are contrived and ordered by the Wiſe Creator, for this grand Uſe in particular, to diſpenſe the moſt neceſſary Proviſion of Water, to all Parts of the Earth: without which neither Animals could live, Plants grow, nor perhaps Foſſils receive any Increaſe. For was the Surface of the Earth even and level, there could be no Deſcent for the Waters, but inſtead of gliding along thoſe gentle Declivities, quite down to the Sea, they would drown large Tracts of Land, and then ſtagnate and putrefy.

INDEED without Hills, as there could be no Rivers, ſo neither could there be any Springs, which we continually find in or near high Grounds, very rarely on Spacious Plains. When we do find any there, it is generally at great and inconvenient Depths. And even theſe are probably owing to Hills, either near, or at ſome diſtance: As we may gather from the impetuous manner wherein theſe ſubterraneous Waters break out, when Wells are dug in the *Lower Auſtria*, or in ſeveral parts of *Italy*. And if there are ſome Iſlands, which ſeem void of Mountains, and nevertheleſs are well watered, in reality the whole Maſs of Land, is no other than One Mountain, deſcending gently and imperceptibly down, from the Midland Parts to the Sea.

CONSIDERING this, there are two or three Acts of Divine Providence, which are highly obſervable. One is, that all Countries throughout the World, ſhould enjoy the great Benefit, of Mountains placed here, and there, at due and proper Diſtances. According to the natural Courſe of things, when the Earth and Waters were ſeparated, and ordered to their reſpective Places, the Earth would have been of one even Surface. The ſeveral component Parts thereof muſt have ſubſided according to their ſpecific Gravities, and at laſt have formed a large, even, ſpherical Surface, every where equidiſtant from the Center of the Globe. But that inſtead of this Form, it ſhould jet out every where into Hills and Dales, is a manifeſt Sign of the eſpecial Providence of a wiſe Creator. Another Sign of this is, that throughout the whole Earth, the Parts fartheſt from the Sea are the higheſt: An admirable Contrivance both for ſupplying all places with Water, and for carrying off the Superfluity of it.

AND as the Mountains themſelves are naturally diſpoſed to be drier than the low Grounds, ſo Nature has provided for them, a more plentiful ſupply of Moiſture, unleſs for that very ſmall Part of them which aſcend above the Clouds and Vapours. For beſide the Fountains which water them continually, they have more Rains and Dews than the Valleys. They are much more frequently covered by Fogs; and by ſtopping and compreſſing the Clouds, as well as condenſing them by their greater Cold, they procure all the Rain they want.

"BUT how were the Mountains formed, after the Flood had diſſolved the terraqueousGlobe?" Probably thus. The ſmaller Hills might eaſily be aggregated by the mere force of the Water. But the Mountains being of a denſer Subſtance, ſeem to have been elevated from beneath, in a convex form, by the violent force of ſubterraneous Wind, Water and Fire, heaving them up and ſcattering them abroad in ſo many protuberances. And if this was done before the Subſtance of the Stones became fixt and indurated, then it is no wonder, that the external Wind likewiſe, ſhould leave ſo manifeſt tokens, of its vehement Impetuoſity, in the Extent and outward Figure of them. This gives an eaſy, natural Account, for the innumerable Fiſſures, Chaſms and Diſruptions, whereby ſo many Mountains are as it were ſawn aſunder, either acroſs or length-ways. And hence many ſuch Apertures in the Mountains, are filled with a ſlimy Matter, which was afterwards indurated. In ſome of the Mountains of *Norway*, this projects in a Range, about an Ell in breadth, betwixt the other ſtony Strata, thro' the whole length or bulk of the Mountain, and from the Variety of its Colours, makes a very pleaſing Appearance. Of theſe Veins ſome conſiſt of Marble or Alabaſter, ſome of Agate, ſome of white, red or blue Stone, which eſpecially toward the Sea, where the Rocks are bare, form many curious variegations. Hence likewiſe there remain on the Surface, many detached Blocks and Fragments, ſcattered not only in the Valleys and Creeks, but on the tops of the higheſt Mountains. Many of theſe are of the bulk of a common Houſe, and conſequently too ponderous, to have been raiſed to ſuch an immenſe height, by the hands or art of Men.

But the largeſt Mountains may have been formed in the following manner. The Sea-Waters doubtleſs remained ſome time on the Earth: and during that time the Surface of the Earth was the bottom of the Sea, where every thing paſſed in the ſame manner as paſſes at the preſent bottom of the Sea. Now the Sea has always had a flux and reflux, and that moſt violent under the Equator, where likewiſe the Earth's Motion cauſes a greater centrifugal force than any where elſe. Suppoſe then the Earth was at firſt quite round, yet its diurnal Motion, with the flux and reflux of the Sea, would have raiſed by degrees the Parts near the Equator, by amaſſing there Shells, Mud and Earth. And as this is performed daily, the Water would carry at each time a ſmall quantity of Matter, which afterward ſinks to the bottom, and forms thoſe parallel Strata, which are every where found.

Thus in fact. On many Shores the Flux brings a great number of things along with it, and leaves them there. So that while it inſenſibly covers ſome Lands, it abandons others, after adding thereto Shells, Earth and Sand, which gradually accumulating, make a Part of the Continent.

On a coaſt againſt which the Sea beats violently, it carries a little Soil away at each tide. Yea, even where it is bordered with rocks, it wears them away by little and little. Theſe Particles the Waters carry to a certain diſtance, where they ſink in the form of a Sediment, and form the firſt Stratum, which will ſoon be covered by another, and ſo with more and more. Hence in time a Mountain will be formed in the bottom of the Sea, entirely like what we ſee on the Land.

Such Eminences lying in the ſame Direction with the Waves that produced them, form by degrees a Chain of Mountains. "But how come Mountains whoſe top is compoſed of Rock, to have only Earth or Sand for their Baſe, which may often be ſeen in the neighbouring Plains, to a conſiderable Diſtance?" We anſwer, the Water firſt tranſported the Sand that formed the firſt Layer at the bottom of the Sea. Afterward the more firm and weighty Subſtances were attacked, and brought by the Waters in an impalpable Powder. And this powder of Stone formed the rocks which now cover theſe Eminences.

THESE Cauſes act with more force under the Equator, as the Winds are there more uniform, and the Tides more violent: And accordingly the greateſt Chain of Mountains is near the Equator. Thoſe of *Afric* and *Peru* are the higheſt we know, which after traverſing whole Continents, ſtretch to very conſiderable Diſtances, under the Waters of the Ocean. The Mountains of the North are no more than Hillocks, when compared to theſe. Moreover the number of Iſles in the Northern Seas is inconſiderable, while there is a vaſt Quantity under the Torrid Zone: And an Iſland is no more than the top of a Mountain.

IT is then doubtleſs the General flux and reflux of the Sea, which has produced the greateſt Mountains. But others we may aſcribe to Currents, Winds, and other irregular Agitations of the Sea, which muſt by their various Combinations, infinitely vary the Direction of the Tides. They are the ſmalleſt of all which owe their Riſe to Earthquakes or other accidental Cauſes.

BUT how ſhall we account for the formation of the *Iron Mountain*, near *Taberg*, in *Sweden?* It is ſituated in a mountainous part of the Country, covered with Sand, near forty Leagues from the Sea. It is an entire Maſs of rich Iron Ore, the perpendicular Heighth whereof is above four hundred feet, and its Circumference three *Engliſh* miles. Oppoſite to it is a Valley, thro' which flows a ſmall River. No Ore is found beyond the foot of it, nor on the neighbouring Plain, ſo that it appears as if the Mountain had been artificially laid on the Sand. For it has no roots, like other Mountains, nor does its Subſtance penetrate the ground. It has all over, many perpendicular and horizontal fiſſures, filled with pure ſand: In the inner Parts whereof Bones of Stags and other Animals are found.

No Hypotheſis hitherto advanced to account for the formation of Mountains, will at all account for this.

The bones found therein ſhew it was owing to ſome ruinous Cauſe. But what that Cauſe was, muſt in all probability ever remain a Secret.

No leſs unaccountable are ſome of the Mountains in *Iceland*, termed by the Natives, *Jokeler*. From the tops of theſe continually flow large ſtreams of a thick, ſooty, ſtinking Water. Theſe occaſion Lakes which increaſe in bulk, and again diminiſh, and change their Appearance almoſt every day. Hence Paths are ſeen in the Sand made by Travellers that paſſed the day before. When followed, they lead to a large pond or lake, which obliges them to go two or three miles round, and then they come to the very path oppoſite to that which they were obliged to leave. But in a few days the lake is, as it were vaniſhed, and the interrupted Path appears again.

It is now well known that the Snows and Rains which fall on the *Mountains of the Moon*, ſo called, in *Afric*, are the real Source of the River *Nile*, which remained a Secret for ſo many Ages. The Cataracts of *Nile*, are likewiſe now well known, but are probably leſs remarkable than that of *Niagara* in *Canada*. The Fall of this is about ſix Leagues from Fort *Niagara*. The whole Courſe of the River for two leagues and an half below the Great Fall is a ſeries of ſmaller Falls, one under another. The Rocks of the Great Fall croſs the River in almoſt a Semicircle. Above the Fall, in the middle of the River, and parallel with the ſides of it, is an Iſland above 400 yards long. The lower End of this Iſland is juſt at the perpendicular Edge of the Fall. On both ſides of this Iſland runs all the water that comes from the Lakes of *Canada*, which indeed are rather Seas than Lakes, receiving many large Rivers. When the Water approaches the Iſland, it runs with an amazing Swiftneſs, and before it comes to the Fall, is quite white, and in many places, is thrown high into the Air. Looking up the River from the Fall, you ſee it is exceeding ſteep, reſembling the Side of an hill. When this vaſt Body of Water comes to the Fall, it throws itſelf down perpendicular. To ſee this ruſh headlong down ſo prodigious a Precipice, ſtrikes the Beholder in a manner not to be expreſt.

It falls one hundred and thirty-ſeven feet. When the water is come down to the bottom, it leaps back to a great height in the Air: At a little diſtance it is white as ſnow, and boils like a chaldron. The Noiſe of it in fair weather is heard fifteen Leagues, yea, many times at *Niagara*. From the place where the Water falls, abundance of Vapour riſes, reſembling a very thick ſmoke. When it is calm this riſes high in the Air. If you go into this vapour, in a few minutes you will be as wet as if you had been under water. In a calm Morning, you may ſee it riſing in the Air, at the diſtance of many Leagues. And a Perſon unuſed to it, would be apt to think, that all the Foreſts thereabouts were on fire.

3. A Body that yields eaſily to the touch, and whoſe Parts making but little reſiſtance againſt being divided, move among themſelves with great Facility, is uſually termed a *Fluid*. *Liquids* are a ſort of Fluid which aſſume the Figure of the veſſels they are contained in, and always keep their upper Surface in a Plain, parallel to the Horizon. Such are Water, Oil, Mercury, which are diſtinguiſhed from other Fluids, by the Paralleliſm of their Surface, in conſequence of their Weight, and the inteſtine Motion of their Parts all manner of ways. That they have ſuch a Motion plainly appears, from their diſſolving hard Bodies. Put a Piece of Copper into a Glaſs of *Aqua-fortis*, and there is firſt an efferveſcence, then the Copper diminiſhes, and at laſt diſappears. And what ſtrong Waters are with regard to Metals, other Liquids are to other Subſtances. Each of them is a diſſolvent, more or leſs, according to its component Particles. Now it is plain that Diſſolution ſuppoſes Motion, and is the effect of it. There is therefore in all Liquors an inteſtine Motion, from which this Effect reſults.

Water is a tranſparent Liquid, capable of Heat and Cold, and of being rarefied into Vapour. But it is not capable of being condenſed, by any Method yet known. It is of itſelf without Smell or Taſte, and liable to Putrefaction. It is heavier by many degrees than Air, and inſinuates where Air cannot enter.

Theſe Properties do unqueſtionably depend on the Figure and Texture of its Parts. But theſe, after our moſt curious Reſearches, it is not poſſible to know with certainty. We can only conjecture, that they are ſmall, round, ſmooth, and in perpetual Motion. Dr. *Boerhaave* ſays, No one ever yet ſaw a drop of pure Water. It is never pure from Salts. For all Water contains Air, and all Air contains Salts.

WATER ſeems to be diffuſed every where, and mixt with all Bodies. Fire itſelf is not without it. Place Salt of Tartar near the hotteſt Fire, and it will imbibe Water, and thereby, in a ſhort time, conſiderably increaſe in weight. So a pewter Veſſel with Ice in it, brought up from a cold Vault into the hotteſt room, in a dry Summer-day, is immediately covered with little drops of Water, which is gathered from the Air, and condenſed by the Coldneſs of the Ice.

INDEED the Quantity of Water which is afforded by the dryeſt Bodies is ſurprizing. Oil of Vitriol long expoſed to violent Fire, to ſeparate it from all its Water, by only ſtanding a few minutes in the Air, will afford as much as at firſt. Hartſhorn kept forty Years, and turned as hard and dry as any Metal, ſo as to ſtrike fire with a flint, yet diſtilled in a Glaſs Veſſel, will yield an Eighth Part of its Quantity in Water. Bones dried five and twenty years, and almoſt as hard as Iron, have by Diſtillation yielded half their weight in Water. Yea, the hardeſt Stones, ground and diſtilled, always afford a portion thereof. All Animals and Vegetables grow out of Water and Salts, and by Putrefaction return to the ſame.

THE chief Properties of Water are, 1. It is, next to Fire, the moſt penetrative of all Bodies. So that a veſſel thro' which Water cannot paſs, will contain any thing. Only ſome Oils will paſs thro' thoſe wooden Veſſels, which contain water. Not that their particles are more penetrative; but thoſe Woods abound with Rozin. This the Oil diſſolves, and then makes its way thro' the Spaces left thereby. Water alſo by degrees makes its way thro' all Wood, and is only retainable by Glaſs and Metals. It finds its way where Air cannot, as thro' Leather, which Air cannot penetrate. Again, Air may be retained in a Bladder: but Water ooſes thro'. Yea, Experiments ſhew, it will paſs thro' Pores ten times ſmaller than Air will. By this very Quality it is fitted to enter into the Compoſition of all Bodies, Animal, Vegetable and Foſſil; with this peculiar Circumſtance, that by a gentle Heat it is ſeparable from them again. By this, joined with its Smoothneſs, it is fit to convey the nutritive Matter of all Bodies. Paſſing ſo readily, it never ſtops up the Pores, but leaves room for the following Supplies. And yet 2. Water, which ſo eaſily ſeparates from moſt Bodies, firmly coheres with ſome: Yea, binds them together in the moſt ſolid Maſſes. So, mixt with Aſhes, it gives the utmoſt Firmneſs. The Aſhes, for inſtance, of an Animal, wrought up with pure Water into a Paſte, and baked with a ſtrong Fire, grows into a Coppel, which bears the utmoſt Heat of a Refiner's Furnace. It is in truth, by the glutinous Nature of Water alone, that our Houſes ſtand. For, take this out of Wood, and it becomes Aſhes; out of Tiles, and they become Duſt.

INDEED all the Stability and Firmneſs in the Univerſe, are owing to Water alone. Thus Stone would be incoherent Sand, did not Water bind it together. And thus of Water and Clay we make Earthen Veſſels, of the utmoſt Hardneſs and Cloſeneſs. And theſe, tho' appearing perfectly dry, yield when diſtilled an incredible Quantity of Water. The ſame holds of Metals, Parings or Filings of which by Diſtillation yield Water plentifully. Yea the hardeſt Stones, Sea-ſalt, Nitre, Vitriol, are hereby ſhewn to conſiſt chiefly of Water.

HENCE we learn, that the component Particles of Water are 1. Infinitely ſmall, whence their penetrative Power, 2. Exceeding ſmooth and ſlippery. Hence their Fluidity, and eaſy Separation from other Bodies. 3. Extremely ſolid. 4. Perfectly tranſparent: 5. Hard, rigid and inflexible: as appears from the abſolute Impoſſibility of compreſſing them.

SALTS melted in Water, do not fill the Veſſel in proportion to their bulk. It follows, that there are Spaces between the Particles of Water, to admit thoſe of the

Salt. Hence alſo we gather, that the watry Particles are extremely ſolid and inflexible, ſince notwithſtanding thoſe Spaces, no power can compreſs, or force them nearer each other.

4. When the Particles of Nitre that float in the Air, wedge the Particles of Water together, they become *Ice.* The Air lodged in the Pores of the Water, is then greatly expanded. Hence the Water is lighter than before: But at the ſame time it is leſs tranſparent: Perhaps becauſe the Paſſage of Light is hindred by the interpoſal of thoſe nitrous Particles.

It is obſervable, 1. That all Liquids, except Oil, dilate in freezing and grow lighter. Nay, even after they are thawed, they are conſiderably lighter than before: 2. That Water will not freeze *in vacuo*: 3. That Water which has been boiled does not readily freeze: 4. That Water covered with Oil of Olives does not freeze readily; covered with Nut-oil, not at all: 5. That Nut-oil, Oil of Turpentine and Spirits of Wine will not freeze at all: 6. That frozen Water is covered with Wrinkles, ſometimes like Rays drawn from a Center to the Circumference.

Tho' Fluids are dilated near a Tenth of their Length, Metals are ſhortned by Froſt. If Veſſels made of Metals, however thick and ſtrong, be filled with Water, cloſe ſtopt and expoſed to Froſt, the Water will burſt the Veſſels. A ſtrong Barrel of a Gun, thus filled and ſtopt, will rend the whole Length. [d]

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[d] Dr. *Plot* obſerves, that Rivers are always found to freeze firſt at their bottoms. The ſame is obſerved by Watermen in the *Thames*, who not only feel it at the bottom with their poles, ſome days before the Surface is froze over, but ſee it riſe up from the bottom, ſo as to dart up in pieces edge-ways, half a foot, ſometime a foot above the Surface. In this Poſture it continues a little time, and then turning flat upon the water, ſwims along the Stream, 'till it meets with other pieces, which if the Froſt continues, all harden into one 'till the river is froze over.

" In a part of the *Thames*, where there was very little Stream, I found the Water, (ſays Dr. *Hale*) in a cold Morning froze one fifth of an inch thick, under which I ſaw a bed of Ice at the bottom. Breaking away ſome of the upper Ice, I took up ſome of the lower

IT has been commonly ſuppoſed, that Fluids not only dilate, but *evaporate* by Cold. And this has long paſſed for an inconteſtable Truth. Yet it is altogether a Miſtake. From later Experiments it undeniably appears, 1. That Cold does not increaſe but leſſen the Evaporation of Water, if it be not expoſed to the Agitation of the Air: 2. That the Evaporation of Water depends on an inteſtin Motion, which it preſerves as long as it is liquid, and that the Air only contributes thereto, by continually tranſporting the Particles detached from the Surface, and thereby giving other Particles room to diſengage themſelves: 3. That frozen Water does not evaporate at all, if it be kept from the Agitation of the Air: 4. That the Diminution obſerved in Ice expoſed to the open Air, is not from any Evaporation, but is the effect of a fine Raſping by the Wind, rubbing againſt it and carrying off its finer Particles. And what is thus detached from Ice is only a very fine Duſt, not more different from Ice than the Duſt of Free-ſtone, cut, from the Stone itſelf.

THIS Duſt carried by the Wind produces intenſe Cold. Nor is it always inviſible. The Air near *Hudſon's Bay* is often filled with Particles of Ice, fine as Hairs and ſharp as Needles; which if they ſtrike againſt the Hands or Face, pierce the Skin and occaſion painful Bliſters.

THE natural State of this Globe ſeems to be, in an intermediate degree between Heat and Cold. And this Natural Warmth of the Earth is what ſecures many Springs from being frozen: The Froſt in *England* ſeldom penetrating

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Ice, which was about half an inch thick. It adhered cloſe to the bottom, where the Stones and Sand were incorporated with it. When it freezes to a conſiderable thickneſs, it will raiſe up with it from the bottom, the Fiſhermen's oſier-wheels, altho' they are ſunk down with Stones or Bricks tied to them."

"STANDING Waters indeed freeze firſt at top, becauſe they are coldeſt there: Whereas in a Stream the upper and lower Waters being continually blended together, are equally cold; and the upper Water meantime having more Motion, cannot freeze ſo ſoon. But here, where the Motion of the Water was ſo ſmall, its Surface was froze as well as the bottom, tho' not ſo thick: Whereas the main River, where its Motion was greater, was not froze over, tho' Cakes of Ice were continually riſing from the bottom."

penetrating the Earth, more than fourteen Inches below the Surface. Even in *Sweden* bubbling Springs do not freeze at all, while the ſtanding Waters freeze three Ells deep.

In the Lakes of *Sweden* the Ice often cracks, with a Rupture nine or ten feet deep, and many Leagues long, and with a Noiſe like Cannon. Hereby the Fiſhes get Air, ſo that few of them are deſtroyed. In *Moſcow* the Earth is often cleft by the Froſt, a foot broad and many yards long. In the Mountains of *Swiſſerland*, there are vaſt Maſſes of Ice, which have lain there for many Centuries. At certain times theſe crack, and by thoſe Cracks one may gueſs at the immenſe Thickneſs of them: Some of the Cracks being 3 or 400 Ells deep, tho' none of them have ever gone thro' the whole thickneſs of the Ice.

We need not then be ſurprized, at the effects of ſevere Froſt on Trees and other Vegetables. How theſe are hurt in hard Winters is eaſily underſtood, if we conſider, that Water when frozen, takes up more Space than it did before; that all Trees, eſpecially thoſe that ſhed their Leaves, drink in a large Quantity of Moiſture in Summer, and that the Veſſels of ſmall Twigs are larger in proportion than thoſe of the Trunk, and conſequently contain more Moiſture. It follows, that being ſurprized by an hard Winter, before their Juices are diminiſhed, or changed into a glutinous nature, which does not ſo eaſily freeze: The Veſſels of the Tree muſt neceſſarily burſt. Conſequently their Juice muſt be extravaſated, and ſo cauſe, as in Animals, the Death of the Tree, by a kind of bleeding, which nothing can ſtop.

In the great Froſt in 1683, Oaks, Aſhes and Walnut-trees were cleft in two and frequently with a terrible Noiſe: And not only their Bodies, but their Branches and Roots alſo. In 1708, the Froſt was almoſt thro' all *Europe*, except *Scotland* and *Ireland*. All the Orange-trees and Olives in *Italy*, *Provence* and many other Countries periſhed: And all the Walnut-trees in *France*, with an infinity of other Trees. In *England* moſt of the Bay-trees, Hollies, Roſemary, and even Furze periſhed. The Sap alſo of Wall-trees ſtagnated in the Branches, and produced Diſorders reſembling Chill-blains. And the very buds of the finer Trees were quite killed, and turned into a kind of mealy Subſtance.

In 1728, toward the End of November, the Winds blew exceeding cold, followed by ſo heavy a Snow, as in one Night broke off large Arms of many ever-green Trees. At this time alſo, there was a great number of large Trees diſbarked. Two *Weſt-India Plane-trees*, in particular, in the Phyſic-Garden at *Chelſea*, which were near forty feet high, and a fathom in circumference, were diſbarked almoſt from the bottom to the top, on the Weſt-Side of the Trees. And it was obſervable, that whatever Trees were diſbarked, it was on the Weſt or South-weſt Side.

The Bodies of Ice in the Northern Seas, near *Hudſon's* Bay, are ſurprizing: Some of them are immerſed an hundred fathoms or more, under the Surface of the Ocean. They ſtand a fifth or ſixth Part above, and are three or four miles in circumference. Theſe floating Mountains owe their durable Nature, to a Cauſe not uſually obſerved; that is, to their not being common Ice, but the Ice of Sea-water. If a Phial of Sea-water, be expoſed to the Air in froſty Weather, 'till Flakes of Ice are formed therein, and then ſet in a warm Room, ſtill the Flakes will remain a long time undiſſolved. And if they are taken out, and expoſed at a ſmall diſtance to the Fire, they will not run into Water, as common Ice would do, but will by degrees evaporate, leaving only a little white Salt. It is eaſy then to conceive, that the immenſe Maſſes of this Ice, found in the Northern Seas, will continue undiſſolved throughout the Year, and at the Return of the freezing Seaſon, grow larger and larger every Year, by the freezing of more Ice about them.

On the contrary, there are ſome Waters, which will not freeze at all. The Lake *Neſs* in *Scotland* never freezes, be the Winter ever ſo ſevere. Yea, while every thing round is frozen, its Waters run ſmoking for ſix miles down the River into which they are diſcharged; and from this Smoke there riſes a ſort of Fog, which overſpreads the Country for ſeveral Miles. Near the Lake is a Mountain, on the Summit of which there is another

Lake, which is always full, Summer and Winter. Due Weſt from the River, there is another Lake, two miles long and ſix broad. The middle of this is ſometimes dry, and then plainly appears to have been once an inhabited Country. There are many Tumuli to be ſeen under Water, one of which is acceſſible at low Water. And in this Urns have been found, which leave no room to doubt of their having been Burial-places.

THERE are likewiſe in *Scotland* other Lakes, which freeze only at peculiar Seaſons. A little Lake in *Straherrick*, never freezes over, be the Froſt ever ſo ſharp, 'till February. But after the firſt Part of this Month, a ſlight Froſt will freeze it over in a Night's time. There are alſo two other remarkable Lakes, in the ſame Country. The one, *Loch Monan*, which is conſiderably large, obſerves the ſame rule, freezing over in February with a ſlight Froſt, but never before, be the Seaſon ever ſo rigorous. The other in *Straglaſh* has a contrary quality. It lies between two high Hills, and is itſelf conſiderably above the level of the reſt of the Country. This freezes continually, having Ice in the middle, even in the hotteſt Summer Months, while the Sun by reflection from the Hills on each ſide, gives a very conſiderable Heat. There are many other Lakes in the neighbouring Country, which yet have no ſuch Property: So that this, and the Property of the two other Lakes, muſt be owing to ſome peculiar Cauſe. The Herbage about the ſides of the Lake laſt mentioned, has a kind of perpetual Spring, which continues thoughout the whole Year, and is much eſteemed by the Country-People, for feeding Cattle in one Month, more than the beſt Land in the Country will do in Two. The Lake is very deep, and the Water does not manifeſt any particuliar Quality.

5. RAIN, Snow and Dew, which riſe in Vapours both from the Earth and Waters, deſcending on Hills, ſink thro' the Earth, 'till they meet with a bed of Clay or Stone. This retains the Water and gathers it together, in a larger or ſmaller Baſon, 'till running over the edge, it makes itſelf a way, and riſes in a *Fountain*. Hence iſſues a *Rivulet*, many of which joining together, con-

ſtitute a *River*, which continues its courſe, 'till it empties itſelf into the grand Receptacle of Water, the Sea.

But it has been aſked, "Is there a ſufficient Quantity of Vapours raiſed, in the ordinary Courſe of Nature, to ſupply the Demand of Fountains and Rivers?" We anſwer, There is abundantly ſufficient, from the Surface of the Sea alone, leaving the Earth out of the account. For it has been ſhewn by clear Experiments, 1. That Water ſalted to about the ſame degree as Sea-Water, and expoſed to a Heat equal to that of a Summer's Day, did from a Circular Surface, eight inches in Diameter, evaporate ſix ounces in 24 Hours. If ſo, the thickneſs of a ſkin of Water evaporated in two Hours, is the 53d part of an inch. But were it only a 60th, it would exhale the Tenth of an inch in two Hours. And on this principle, every Ten ſquare Inches of the Surface of Water, yield in vapour a ſquare inch of Water daily: Each ſquare foot, half a Pint: Every Space of four foot ſquare, a Gallon; a Mile Square, 6914 Tons: A Quantity abundantly ſufficient to furniſh, both Dews, Rains, Springs and Rivers. So that we need not have recourſe for Supplies to the great Abyſs, whoſe Surface, at high Water, is ſurmounted ſeveral hundred feet, even by ordinary Hills: And ſome thouſands, by thoſe vaſt Mountains, from whence the largeſt Rivers take their Courſe.

Nevertheless we may allow a different Riſe to thoſe Springs, which ebb and flow with the Sea: As likewiſe to thoſe Lakes, whoſe Water is Salt, and which have Sea-fiſh in them, altho' they have no Communication with any Sea, by any viſible Paſſage.

To explain this a little more at large. It is evident from experience, that a Vapour is perpetually riſing from the Sea, Rivers and Lakes. The Winds carry this Vapour thro' the Atmoſphere, in the form of a Cloud or Miſt. When it meets with a colder Air, or is ſtopt by Mountains, it condenſes, and falls to the Earth. As it falls, it finds ſeveral Chinks and Crannies, thro' which it inſinuates into the Mountains, and lodges there, 'till increaſing its Store, it burſts out and takes the name of a Fountain.

THAT this is really the caſe, will eaſily be allowed, by all who ſeriouſly conſider, 1. That the Vapours riſing from the Sea, are more than ſufficient to ſupply both the Surface of the Earth and the Rivers with Water, 2. That the Mountains, by their particular Structure, arreſt the Vapours that float in the Atmoſphere, and having collected them in their Reſervoirs, diſmiſs them again thro' their ſides, either in perpetual or intermitting Currents.

WITH regard to the firſt, It has been ſhewn, that every ten ſquare inches of the Surface of the Sea, yields a Square inch of Water daily; Every Square Mile 6914 Tons; and perſuing the ſame proportion, every Square Degree (or 69 *Engliſh* Miles,) will yield 33 Millions of tons. Now if we ſuppoſe the *Mediterranean* to be forty Degrees long, and four broad at a Medium, (which is the leaſt we can ſuppoſe) its Surface will be 160 ſquare Degrees: From whence there will in Summer evaporate daily 5280 Millions of Tons.

THE *Mediterranean* receives Water (to ſay nothing of ſmall and inconſiderable Streams) from Eight large Rivers, the *Iberus*, the *Rhine*, the *Po*, the *Danube*, the *Neiſter*, the *Boryſthenes*, the *Tanais* and the *Nile*. Now ſuppoſe each of theſe conveys ten times as much Water to the Sea as the *Thames*. The *Thames* has been ſhewn, to pour daily into the Sea 203 Millions of Tons. Therefore all thoſe Rivers will produce 1827 Millions of Tons. But this is little more than one Third of the Quantity daily evaporated from the Sea. How prodigious a Quantity then remains for Rains and all other purpoſes?

LET us obſerve, Secondly, how the Mountains arreſt, and collect theſe Vapours, and then diſcharge them in Springs.

THE Tops of Mountains in general abound with inequalities, Cavities, Grottos and gaping Cells. The floating Vapours are ſtopt by theſe and by their pointed Summits, and being condenſed thereby, precipitate in Water, eaſily penetrate thro' Sand and lighter Earth, and gather in Baſons of Clay or Stone, 'till they overflow and work a paſſage thro' the Side of the Mountain.

AND yet we need not deny, that ſome Springs may ariſe from the Sea, or the Great Abyſs: Thoſe in particular,

cular, which at all times afford the ſame Quantity of Water. Some of theſe are found in almoſt every Country. There is one near *Upminſter* in *Eſſex*; which in the greateſt Droughts, and when all the Brooks are dried up, is little, if at all diminiſhed. And in the wetteſt Seaſons, it is not increaſed, unleſs violent Rain falling into it, or running into it from the higher grounds, raiſe it for a day, or a few Hours.

As to the Manner how the Water riſes in ſuch Springs it may eaſily be repreſented, by putting a ſmall Heap of Sand in a Baſon, and then pouring in Water. Here the Sand will repreſent the dry Land, and the Water the Sea round about it. And as the Water in the Baſon riſes, to or near the top of the Heap, juſt ſo do the Waters of the Sea riſe, to the top of the Land with which it communicates.

6. Some think the Earth intirely covered *the Sea*, 'till at the Deluge *the fountains of the great deep were broken up*. And it is highly probable, there is ſtill an Abyſs of Waters within the Earth, which has an uninterrupted Communication with ſome Part of the Outward Sea: The *Mediterranean* in particular, which has no viſible Outlet, while it receives ſo many vaſt Rivers, with an immenſe Quantity of Water, continually pouring in thro' the *Straits*.

The immediate Cauſe of the Deluge, was probably that Comet, which (as Mr. *Whiſton* ſhews) paſſed toward the Sun, juſt before the Earth, on the firſt Day of the Deluge. The conſequence of this muſt be, that when it came below the Moon, it muſt raiſe a vaſt and ſtrong Tide, both in the Waters that were on the Antediluvian Earth, and alſo in the great Abyſs, which was under the Cruſt of the Earth. This Tide muſt increaſe all the time, that the Comet was approaching toward the Earth; and would be at its greateſt Height, when the Comet was at the leaſt diſtance from it. By the force of this internal Tide, as well as by the Attraction of the Comet; the Abyſs which was nearly round before, would then become oblong. And this muſt immediately extend, and then burſt the incumbent Cruſt. And thus,

according

according to the expreſſion of Moſes, the *fountains of the great deep were broken up*.

AGAIN. As the ſame Comet for a conſiderable time involved the Earth in its Atmoſphere, it muſt have loſt a vaſt Quantity of its Vapours, moſt of which would fall on the Earth in violent Rain. And thus *the windows of heaven were opened.* To remove this vaſt Orb of Water, he ſuppoſes a mighty Wind to have riſen, which dried up ſome, and forced the reſt into the Abyſs again, thro' the Clefts by which it came up. Only Part of it ſtayed in the Channel of the Ocean, now firſt made to receive it, and in the leſſer Cavities, placed up and down, on the Surface of the Globe.

THE preſent Diſtribution of the Waters and the Dry-land, tho' it may ſeem rude and undeſigned to a careleſs view, yet is admirably well adjuſted to the uſe and conveniences of our World. In the firſt place, they are ſo diſtributed all the world over, that there is a juſt Æquipoiſe of the whole Globe. The *Northern* balances the *Southern Ocean*, the *Atlantic*, the *Pacific Sea*. The *American* Dry-land is a Counterpoiſe to the *European*, *Aſiatic* and *African*. In the next place, the Waters are ſo admirably well placed about the Globe, as to afford ſufficient Vapours for Clouds and Rain, to temper the Cold of the Northern and Southern Air, to mitigate the Heats of the Torrid Zone, and to ſupply freſh Waters to Fountains and Rivers. Nay ſo abundant is this great Bleſſing, that we have more than a bare Sufficiency, even a Surpluſage of this uſeful Creature: And yet ſo well ordered, as not to drown the Earth, not to ſtagnate, putrefy or annoy its inhabitants; but to glide gently thro' convenient Channels back again to its grand Fountain, the Sea: And many of the Rivers thro' ſuch large Tracts of Land, and to ſuch prodigious Diſtances, that 'tis a wonder the Fountain ſhould be high enough, or the Sea low enough for ſo long a Conveyance. Witneſs the *Danube* and *Wolga* in *Europe*, the *Nile* and *Niger* in *Afric*, the *Ganges* and *Euphrates* in *Aſia*, with the *Amazon's River* and *Rio de la Plata* in *America*: O which ſome run above 5000, ſome 6000 miles from their fountain to the Sea. No accidental Currents or Alterations of the Waters themſelves, no Art or Power of Man, nothing leſs than the Power of the Almighty, could ever have made or found, ſo long and commodious Declivities and Channels, for the Paſſage of thoſe Waters.

Besides the Rivers which run upon the Surface of the Earth, there are many which hide themſelves in its Bowels, and run in ſubterraneous Ducts, 'till they diſcharge themſelves into the Sea. A remarkable one of this kind has been diſcovered on the coaſt of *Languedoc.* There are alſo ſeveral of this ſort on the Coaſt of *Croatia,* over againſt *Venice.*

Thus does the All-wiſe Creator ſhower down his Treaſures on the Summits of the Mountains, which afterward diffuſe their refreſhing Streams over the Plains below, give Life and Verdure to the Trees and Herbs, and beautify and enrich the whole Earth. At the ſame time we ſee the Communication between thoſe Parts of Nature, that before ſeemed to have no relation to each other. Indeed all Nature is linked together by one Law of Harmony, which ſufficiently proves it to be the Work of One Wiſe and gracious Author.

How delightful an object is a large and majeſtic River! How graceful an Appearance does it make in the Works of Nature! Conſider its Progreſs. At firſt it is but a Vein of Water, ſtreaming from ſome Hill, and even the ſcattered Pebbles interrupt its Courſe, 'till it unites with other kindred Streams, and then ruſhes on the Plain below. By its Fall it hollows the Ground, caſting it up on each Side: Then it perſues its Courſe, eating a Paſſage thro' every thing that oppoſes it. When it has received the Supplies of many Rivulets, it is dignified with a Name. Thus inlarged, it makes the Tour of Hills and Mountains, and at once adorns and inriches the Plains.

At the Deluge likewiſe the main *Iſlands* of the Globe were formed. But it is certain others have been formed in later Ages; Partly by the caſting up of vaſt Heaps of Clay, Mud and Sand, (as that of *Tſongming* in the *Chineſe* Province of *Nanquin*) Partly by the violence of the Sea, tearing off large Provinces from the Continent. So the Antients imagined *Sicily* to have been formed, and even *Great Brittain* and *Ireland*. It it certain alſo, that others have emerged out of the Sea, as *Santorini* formerly: And three other Iſlands near it lately. The laſt of theſe roſe in 1707, from the bottom of the Sea, juſt after a violent Earthquake. Indeed Earthquakes, Storms, and Inundations, have given riſe to many Iſlands: Particularly in the *Eaſt-Indies*, where they are very frequent, and which abound in Iſlands above any part of the World.[e]

7. THE entire *Baſon* of the Sea, is of ſuch immenſe Extent, and covered in many places with ſuch an unfathomable Depth of Water, that it cannot be traced in every Part: But from ſome, we may form a probable Judgment of the reſt. The Materials which compoſe the bottom of the Sea, muſt in a degree influence the Taſte of its Waters. Its Saltneſs it undoubtedly derives from Mountains of Salt which are found there; Its Bitterneſs, from foſſil Coal and other bituminous Subſtances, which are there in plenty. There may likewiſe be many other Subſtances there, which the

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[e] PERHAPS ſome *Moraſſes* too have been ever ſince the Deluge. In ſome of theſe are found, many foot deep, whole Foreſts of Timber, and frequently of ſuch ſorts as have not grown in thoſe Countries for many Ages. The Moraſſes in *Ireland* are covered with an heathy Scurf, under which is a black, moiſt, ſpungy Earth, ordinarily from three to eight foot deep, tho' ſometimes twenty or thirty. Where this is cut away, the Pits fill up again in ſome years, with a new, ſpongy Earth, which ſoon grows as firm as before, and a heathy Scurf covers it again.

BUT ſome Moraſſes are only of late date. Lord *Cromartie* gives a remarkable Account, of what he himſelf obſerved with regard to the Generation of ſuch a Moraſs. In the Pariſh of *Lochburn* he ſaw, near the top of a very high Hill, a Plain about a mile over. It was then covered with a ſtanding Wood, but ſo old, that the Trees had neither Leaves nor Bark left. When he came by the place fifteen years after, he obſerved all the Trees were fallen. A few Years after that, they were quite covered over with a ſoft, ſpongy Earth, which formed a proper Bog or Moraſs. Many may have been formed the ſame way.

Plummet does not diſcover. For the true bottom of the Sea is often concealed by another accidental Bottom, formed of various Subſtances mingled together, and covering it to a conſiderable Depth.

THE entire Gulf of *Lyons* forms a Bank above the Surface of the Water at the Shore, of the exact Figure of an Arch. And within this there is formed another ſuch Arch, making the bottom of the Sea for a great way from ſhore, of different depths in various Places, but generally between Sixty and Seventy Fathoms. In general the Bed of the main Sea ſinks about as high as the Mountains riſe on the Land. Near the Land, in proportion to the height and ſteepneſs of the Shores, the Sea is deep below. And on the contrary, level Shores denote ſhallow Seas.

BY the Strata on the Shores we may commonly judge of the bottom of the adjacent Seas. For the Veins of Salt and Bitumen doubtleſs run on in the ſame order as we ſee them at land. And the Strata of Stone that ſerve to ſupport the Hills and elevated places on ſhore, ſerve alſo in the ſame continued Chain, to ſupport the Waters of the Sea. Probably the Veins of Metals and Minerals likewiſe, which are found in the neighbouring Earth, are in the ſame manner to be found in the bottom of the Sea.

BUT the natural Surface of the bottom of the Sea, is greatly changed by ſubterranean Currents. As we ſee theſe break out in Rivers, on the Surface of the Earth, ſo we may be aſſured they break out at the bottom of the Sea, and empty their freſh Waters into the ſalt Maſs. In this caſe the continual ruſhing up of the Water, makes a roundiſh Cavity. And its running on, continues that Cavity, 'till by degrees it is loſt. Thus every River that ariſes in the bottom of the Sea, makes a baſon and a channel for itſelf. Many Seas, when the Water near the Shore is clear, ſhew the traces of theſe Currents, even to the naked Eye, and the Water taken up from them, is more or leſs freſh.

AGAIN. The Coral-Fiſheries give us occaſion to obſerve, that there are many large Caverns in the bottom of the Sea, eſpecially where it is rocky, as alſo in the Sides of perpendicular Rocks. Theſe are often of great Depth as well as Extent, ſome with wide, others with narrow Entrances. Nor is it any wonder, that as we daily find vaſt Caverns on the Land in rocky Mountains, ſo we ſhould find them in Rocks under the Sea. Nay, we may expect them in theſe the rather, as the Rocks at land are in a State of Reſt, while thoſe at Sea are continually waſhed by the Water, which inſinuates every where, and by its continual Agitation, inlarges every Cavity it finds.

Upon the whole, it ſeems plain, that the Baſon of the Sea was after the Flood compoſed of the ſame Subſtances, as the Surface of the reſt of the Earth, namely ſtone, clay, ſand and the like. It is true, the Plummet in ſounding uſually brings up a matter compoſed of Mud, dead Weeds, broken Shells, and various Bodies cemented together by a ſparry or tartarous Subſtance. But theſe are only an artificial Bottom, covering the Natural one, ſuch indeed as one might expect, where numerous Animals and Vegetables are produced and decay, and where the quiet Waters have time to depoſit their ſtony matter, as our petrifying Springs do.

There are Places however where this adventitious Cruſt is not found, but the natural bottom appears, of the ſame Nature with the Strata in the body of the Earth. But the fine and pure Sand we ſometimes find, ſeems not to be the original Bottom, but to have been rather brought into the Sea by the courſe of ſome ſubterranean River, and to be lodged in one of thoſe particular Baſons, which theſe Rivers form to themſelves.

In deep Water, where the Surface only is diſturbed by Storms and the lower Part remains more quiet for Ages, the bottom is covered with great Variety of things: Sometimes with pure Sand, ſometimes a ſort of ſand, made of Shells beat to powder, ſometimes with powdered Corals, ſometimes fragments of Rocks. But beſide theſe, which might well be expected, the Plummet ſometimes brings up Subſtances, which are of the moſt beautiful Colours: Of as fine a ſcarlet, purple or blue, as the fineſt Paint could make them:

Thoſe of a bright yellow are very common; but the green, or ſnow-white more rare. Theſe coloured Subſtances ſeem ſometimes to make up the whole bottom. But they are more frequently found on other things, as upon mud, corals, or larger pieces of Shells, in the manner of tartarous Cruſts. And their Colours are not merely ſuperficial or tranſient, but many of them are ſo permanent, that they may be preſerved in white Wax, and when thus examined, they appear equal to Paints of the fineſt kind.

8. At fixt times the Water of the Sea runs for near ſix Hours from South to North, which is called the *Flood*, at which time it riſes gradually on our Shores, and in the Channels of the Rivers. Then after ſtanding at the ſame Height for a quarter of an hour, it returns for near ſix hours from North to South, which we term the *Ebb*; and after a quarter of an hour, the Water riſes again. The Change therefore is twice in 24 hours, but begins near fifty Minutes later daily. And this is obſerved on all the Shores of *Europe*, that are waſhed by the Ocean: Whereas the *Baltic* and *Mediterranean* Sea, as well as the *Caſpian*, have no Tides. The nearer we approach the Pole, the more impetuous the Tides are. The Cauſe of them was wholly concealed from the Antients; but it is now well known to every one. They depend entirely on the Motion of the Moon, with which they exactly correſpond: The Flood beginning to riſe juſt at the time when the Moon is in the Meridian.

9. *Currents* in the Sea are either Natural and General, ariſing from the daily Rotation of the Earth on its Axis, or Particular and Accidental, cauſed by the Waters being driven againſt Promontories, or into Gulphs and Straits, where wanting room to ſpread, they are driven back and ſo diſturb the ordinary Flux of the Sea. The Currents are ſo violent near the Line, where the Motion of the Earth is the greateſt, that they carry Veſſels ſwiftly from *Afric* to *America*, but prevent their returning the ſame way. So that they run as far as the fortieth Degree, to find a Paſſage into *Europe*.

In the *Straits* of *Gibraltar*, which are about twenty miles broad, the Current almoſt always runs Eaſtward. And ſo it uſually does in *St. George's Channel* But the moſt violent Sea is in the *Straits* of *Magellan*, which is owing to two contrary Currents, which meet in thoſe Straits.

Sometimes there is an *Under-current*, contrary to that above. So it is in the *Baltic Sound*. One of the King's Frigates being there, they went with their Pinnace into the mid Stream, and were carried violently by the Current. Soon after they ſunk a baſket with a large Cannon Bullet to a certain Depth of Water. This checked the Motion of the Boat. And when they ſunk it lower, the Boat was driven a head againſt the Wind as well as the upper Current. And the lower the Baſket was let down, the ſtronger the Current was found. The upper Current appeared by this Experiment, not above four or five fathom deep.

To this ſhort Sketch of what is obſervable in the Terraqueous Globe, I ſubjoin ſome of the beautiful Reflections of Mr. *Harvey*. "What an admirable Specimen have we here, of the divine Skill and Goodneſs? This Globe is intended, not only for an Habitation, but for a Storehouſe of Conveniencies. And if we examine the ſeveral Apartments of our great Abode, we ſhall find reaſon to be charmed with the Diſplays both of nice Œconomy and boundleſs Profuſion.

The *Surface* of it, the Ground, coarſe as it may ſeem, is yet the *Laboratory* where the moſt exquiſite Operations are performed. And tho' a Multitude of Generations have been accommodated by it, it ſtill continues inexhauſtible.

The *Unevenneſs* of the Ground, far from being a Defect, heightens its Beauty and augments its Uſefulneſs. *Here* it is ſcooped into deep and ſheltered Vales, almoſt conſtantly covered with Verdure, which yields an eaſy Couch and agreeable Food to the various tribes of Cattle. There it extends into a wide, open Country, which annually bears a copious Harveſt: An Harveſt not only of the *principal Wheat*, which is the ſtaff of our Life, but of the *appointed Barley*, and various other Grain, which are Food for our Animals.

THE Furrows vary their Produce. They bring forth *Flax* and *Hemp*, which help us to ſome of the moſt neceſſary *Accommodations* of Life. Theſe are wove into ample volumes of Cloth, which fixt to the Maſt, give Wings to our Ships. It is twiſted into vaſt Lengths of Cordage, which give Nerves to the Crane and Sinews to the Pulley, or elſe adhering to the Anchor, they ſecure the Veſſel, even amidſt the driving Tempeſts. It covers our Tables with a graceful Elegance, and ſurrounds our bodies with a cheriſhing Warmth.

YONDER ariſe the Hills, like a grand Amphitheatre! Some are clad with mantling Vines, ſome crowned with towring Cedars, ſome ragged with miſhapen Rocks, or yawning with ſubterraneous Dews. And even thoſe inacceſſible Craggs, thoſe gloomy Cavities, are not only *a refuge for the wild goats*, but ſometimes for *thoſe of whom the world was not worthy*.

AT a greater diſtance the Mountains penetrate the Clouds with their aſpiring Brows. Their Sides *arreſt* and *condenſe* the Vapours, as they float along. Their caverned Bowels *collect* the dripping Treaſures, and ſend them gradually abroad by trickling Springs: And hence the Waters increaſing roll down, 'till they have ſwept thro' the moſt extenſive Climes, and regained their native Seas.

THE *Vine* requires a ſtrong Reflection of the Sunbeams and a large proportion of Warmth. How commodiouſly do the Hills and Mountains miniſter to this purpoſe. May we not call thoſe vaſt Declivities the *Garden-Walls* of Nature? Theſe concenter the Solar Fire, and compleatly ripen the Grape! O that any ſhould turn ſo valuable a Gift of GOD into an Inſtrument of Sin!

WHAT is Nature but a Series of Wonders? That ſuch a Variety of Fruits ſhould riſe from the inſipid, ſordid Earth? I take a walk thro' my Garden or Orchard in *December*. There ſtand ſeveral Logs of Wood on the ground, They have neither Senſe nor Motion; yet in a little time they are beautified with Bloſſoms, they are covered with Leaves, and at laſt loaded with Fruit. I have wondered at the account of thoſe prodigious Engines, invented by *Archimedes*. But what are all the Inventions of Men, to theſe nice Automata of Nature?

THE *Foreſt* rears Myriads of maſſy Bodies, which tho' neither gay with Bloſſoms, nor rich with Fruit, ſupply us with Timber of various kinds. But who ſhall cultivate them? The toil were endleſs. See therefore the ever wiſe and gracious Ordination of Providence! They have no need of the Spade or the Pruning-knife. They want no help from Man.

WHEN ſawed into Beams they ſuſtain the Roofs of our Houſes. They make Carriages, to convey our heavieſt Loads. Their Subſtance is ſo pliant, that they are eaſily formed into every kind of Furniture: Yet their Texture ſo ſolid, that they compoſe the moſt important Parts of the largeſt Engines. At the ſame time their Preſſure is ſo light, that they float upon the Waters. Thus while they ſerve all the Ends of Architecture, and beſtow numberleſs Conveniencies on the Family, they conſtitute the very Baſis of Navigation, and give Being to Commerce.

IF we deſcend from the *Ground-floor* of our Habitation into the ſubterraneous Lodgments, we ſhall find there alſo the moſt exquiſite Contrivance, acting in concert with the moſt profuſe Goodneſs. Here are various *Minerals* of ſovereign Efficacy: Beds fraught with *Metals* of richeſt value: And Mines, which yield a Metal of a meaner Aſpect, but ſuperior Uſefulneſs. Without the Aſſiſtance of *Iron*, what would become of all our Mechanic Skill? Without this we could ſcarce either fix the Maſt, or drop the faithful Anchor. We ſhould ſcarce have any Ornament for polite, or Utenſil for common Life.

HERE is an inexhauſtible Fund of *combuſtible* Materials. Theſe mollify the moſt ſtubborn Bars. They melt even the moſt ſtubborn Flint, and make it more ductile than the ſofteſt Clay. By this means we are furniſhed with the moſt curious and ſerviceable Manufacture in the World; which admits into our Houſes the chearing

Light, yet excludes the Wind and Rain: Which gives new Eyes to decrepit Age, and more inlarged Views to Philoſophy; bringing near what is immenſely remote, and making viſible what is immenſely ſmall.

HERE are *Quarries* ſtocked with Stones, which do not ſparkle like Gems, but are more eminently uſeful. Theſe form Houſes for Peace, Fortifications for War. Theſe conſtitute the Arches of the Bridge, the Arms of the Mole or Quay, which ſcreen our Ships from the moſt tempeſtuous Seas. Theſe are comparatively ſoft while in the bowels of the Earth, but harden when in the open Air. Was this remarkable peculiarity reverſed, what Difficulties would attend the Labours of the Maſon? His Materials could not be extracted from their Bed, nor faſhioned without infinite toil. And were his Work compleated, it could not long withſtand the Fury of the Elements.

HERE are various Aſſortments and Beds of *Clay*, which however contemptible in its appearance, is abundantly more beneficial than the Rocks of Diamond or Veins of Gold: This is moulded into Veſſels of any ſhape and ſize: Some ſo delicately fine, as to ſuit the Table of a Princeſs; others ſo remarkably cheap, that they miniſter to the Convenience of the pooreſt Peaſant: All ſo perfectly neat, as to give no diſguſt even to the niceſt Palate.

A MULTIPLICITY of other valuable Stores is locked up in theſe ample Vaults. But the Key of all is given to Induſtry, in order to produce each as Neceſſity demands.

WHICH ſhall we moſt admire, the Bounty or Wiſdom of our great Creator? How admirable is his Precaution in removing theſe cumbrous Wares from the Surface, and beſtowing them under the ground in proper Repoſitories? Were they ſcattered over the Surface of the Soil, it would be embarraſt with the enormous Load. Our Roads would be blocked up, and ſcarce any room left for the Operations of Huſbandry. Were they, on the other hand, buried at a great Depth, it would coſt us immenſe pains to procure them. Were they uniformly ſpread into a Pavement for nature, univerſal

Barrenneſs muſt enſue: Whereas at preſent we have Magazine of Metallic, without leſſening our Vegetable Treaſures. Foſſils of every kind inrich the Bowels, Verdure adorns the Face of the Earth.

WELL then may even the Inhabitants of Heaven, lift up their voice and ſing, *Great and marvellous are thy works,* O LORD GOD *almighty!* And is there not infinite reaſon for Us to join this triumphant Choir? Since all theſe things are to Us, not only a noble Spectacle, bright with the diſplay of our Creator's Wiſdom, but likewiſe an ineſtimable Gift, rich with the Emanations of his Goodneſs? *The earth hath he ſet before* the Inhabitants of his Glory: But he hath *given it to the Children of men.* Has He not then an undoubted Right to make that tender demand, "*My ſon, give me thy heart!*"

THE *Rocks,* which bound *the Sea* are here prodigiouſly high and ſtrong, an everlaſting barrier againſt both Winds and Waves. Not that the omnipotent Engineer has any need of theſe Here. it is true, they intervene, and not only repreſs the rolling Billows, but ſpeak the amazing Majeſty of the Maker. But in other Places the Creator ſhews, he is confined to no Expedient. He bids a Bank of deſpicable Sand repel the moſt furious Shocks of aſſaulting Seas. And tho' the waves toſs themſelves, they cannot prevail; tho' they roar, yet they cannot paſs over.

BENEATH the Rocks frequently lies a ſmooth, level Sand, almoſt as firm as a well-compacted Cauſe-way: inſomuch that the tread of an Horſe ſcarce impreſſes it, and the waters never penetrate it. Without this wiſe Contrivance the ſearching Waves would inſinuate into the heart of the Earth; and the Earth itſelf would in ſome Places be hollow as an Honey-comb, in others, bibulous as a Sponge. But this cloſely-cemented Pavement is like *claying* the bottom of the univerſal Canal: So that the returning Tides only conſolidate its Subſtance, and prevent the Sun from cleaving it with Chinks.

HERE the Main rolls its Surges from World to World. What a Spectacle of Magnificence and Terror! How it fills the mind and amazes the Imagination! 'Tis the moſt auguſt Object under the whole Heaven. What are all the Canals on Earth, to this immenſe Reſervatory? What are the proudeſt Palaces on Earth, to yonder Concave of the Skies? What the moſt pompous Illuminations, to this Source of Day? They are a Spark, an Atom, a Drop. Nay in every Spark and Atom and Drop, that proceeds from the hand of the Almighty, there is the manifeſtation of a Wiſdom and a Power abſolutely incomprehenſible.

LET us examine a ſingle Drop of Water, only ſo much as will adhere to the point of a Needle. In this Speck an eminent Philoſopher computes no leſs than thirteen thouſand Globules. And if ſo many thouſand exiſt in ſo ſmall a Speck, how many, in the unmeaſured Extent of the Ocean? Who can count them? As well may we graſp the Wind in our Fiſt, or mete out the Univerſe with our Span.

NOR are theſe Regions without their proper Inhabitants, cloathed in exact conformity to the Clime: Not in ſwelling Wool, or buoyant Feathers, but with as much Compactneſs and as little Superfluity as poſſible. They are clad, or rather *ſheathed* in *Scales*, which adhere cloſe, and are laid in a kind of natural Oil: than which Apparel nothing can be more light, and at the ſame time nothing more ſolid. It hinders the Fluid from penetrating their Fleſh: it prevents the Cold from chilling their Blood; and enables them to make their way thro' the Waters, with the utmoſt Facility. And they have each an *Air-bladder*, a curious Inſtrument, by which they riſe to what Height, or ſink to what Depth they pleaſe.

'TIS impoſſible to enumerate the ſcaly Herds. Here are Animals of monſtrous Shapes and amazing Qualities. The upper Jaw of the *Sword-fiſh* is lengthened into a ſtrong and ſharp Sword, with which (tho' not above fifteen feet long) he ſcruples not to engage the Whale himſelf. The *Sun-fiſh* is one round Maſs of Fleſh; only it has two Fins, which act the part of Oars. The *Polypus*, with its numerous Feet and Claws, ſeems fitted only to crawl. Yet an Excreſcence riſing on the back enables it, to ſteer a ſteddy Courſe in the waves. The Shell of the *Nautilus* forms a kind of Boat, and he unfurls a Membrane to the Wind for a Sail. He extends alſo two Arms, with which as with Oars he rows himſelf along. When he is diſpoſed to dive, he ſtrikes ſail, and at once ſinks to the bottom. When the weather is calm he mounts again, and performs his Voyage without either Chart or Compaſs.

HERE are Sholes upon Sholes of every Size and Form; Some lodged in their Shells, ſeem to have no higher Employ, than imbibing Nutriment, and are almoſt rooted to the Rocks on which they lie: While others ſhoot along the yielding Flood, and range the ſpacious Regions of the Deep. How various is their Figure! The Shells of ſome ſeem to be the rude Production of Chance, rather than of Skill or Deſign. Yet even in theſe we find the niceſt Diſpoſitions. Uncouth as they are, they are exactly ſuited to the Exigencies of their reſpective Tenants; Some on the other hand are extremely neat. Their Structure is all Symmetry and Elegance. No Enamel is comparable to their Poliſh. Not a Room in all the Palaces of *Europe*, is ſo adorned as the Bedchamber of the little Fiſh that dwells in Mother of Pearl. Where elſe is ſuch a mixture of Red, Blue and Green, ſo delightfully ſtaining the moſt clear and gliſtering Ground?

BUT what I admire more than all their Beauty, is the Proviſion made for their *Safety*. As they have no Speed to eſcape, ſo they have no Dexterity to elude their Foe. So that were they naked, they muſt be an eaſy Prey to every Free-booter. To prevent this, what is only Cloathing to other Animals, is to them a Cloathing, an Houſe and a Caſtle. They have a Fortification which grows with them, and is a Part of themſelves. And by means of this they live ſecure amidſt Millions of ravenous Jaws.

HERE dwell Mackrel, Herring, and various other kinds, which when lean wander up and down the Ocean; but when fat, they throng our Creeks and Bays, or haunt the running Streams. Who bids theſe Creatures leave our Shores, when they become unfit for our Service? Who rallies and recalls the undiſciplined Vagrants, as ſoon as they are improved into deſirable Food? Surely the Furlow is ſigned, the Summons iſſued, and the point of Re-union ſettled, by a Providence ever indulgent to Mankind, ever loading us with Benefits.

THESE approach, while thoſe of enormous Size and Appearance abandon our Shores. The latter would fright the valuable Fiſh from our Coaſts; they are therefore kept in the Abyſſes of the Ocean: Juſt as Wild Beaſts, impelled by the ſame over-ruling Power, hide themſelves in the Receſſes of the Foreſt.

ONE Circumſtance relating to the Natives of the Deep is very aſtoniſhing. As they are continually obliged to devour one another for neceſſary Subſiſtence, without extraordinary Recruits, the whole watry Race muſt ſoon be totally extinct. Were they to bring forth no more at a Birth than Land Animals, the Increaſe would be far too ſmall for the Conſumption. The weaker Species would ſoon be deſtroyed by the ſtronger, and the ſtronger themſelves muſt ſoon after periſh. Therefore to ſupply Millions of Animals with their Food, and yet not depopulate the watry Realms, the Iſſue produced by every Breeder is almoſt incredible. They ſpawn, not by Scores, but by Millions: A ſingle Female is pregnant with A Nation. Mr. *Lewenhœck* counted in an ordinary Cod 9,384,000 Eggs. By this amazing Expedient, conſtant Reparation is made, proportionable to the immenſe Havock.

AND as the Sea abounds with animal Inhabitants, ſo it does alſo with vegetable Productions: Some ſoft as Wool, others hard as Stone. Some riſe like a leafleſs Shrub, ſome are expanded in the form of a Net: Some grow with their Heads downward, and ſeem rather hanging on, than ſpringing from the Juttings of the Rocks. But as we know few Particulars concerning theſe, I would only offer One Remark in general. The Herbs and Trees on the dry Land are fed by the Juices that permeate the Soil and fluctuate in the Air. For this purpoſe they are furniſhed with Leaves to collect the one, and with Roots to attract the other. Whereas the Sea Plants, having ſufficient Nouriſhment in the circumambient Waters, have no need to detach Roots into the Ground, or forage the Earth for Suſtenance. Inſtead therefore of penetrating, they are but juſt tacked to the bottom, and adhere to ſome ſolid Subſtance, only with ſuch a degree of Tenacity, as may ſecure them from being toſt to and fro by the agitation of the Waves. We ſee from this and numberleſs other Inſtances, what Diverſity there is in the Operations of the great Creator. Yet every Alteration is an Improvement, and each new Pattern has a peculiar Fitneſs of its own.

CONSIDERED in another view, the Sea is that *grand Reſervoir*, which ſupplies the Earth with its Fertility: And the Air and Sun are the mighty Engine, which work without Intermiſſion, to raiſe the water from this inexhauſtible Ciſtern. The Clouds as Aqueducts convey the genial Stores along the Atmoſtphere, and diſtribute them in ſeaſonable and regular proportions, thro' all the Regions of the Globe.

How hardly do we extract a drop of perfectly-ſweet Water from this vaſt Pit of Brine? Yet the Sun draws off every moment Millions of Tons in vaporous Exhalations, which being ſecurely lodged in *the bottles of heaven*, are ſent abroad ſweetened and refined, without the leaſt brackiſh tincture, or bituminous Sediment: Sent abroad upon the wings of the wind, to diſtil in Dews, and Rain, to ooze in Fountains, to trickle along in Rivulets, to roll from the Sides of Mountains, to flow in copious Streams amidſt burning Deſerts and thro' populous Kingdoms, in order to refreſh and fertilize, to beautify and inrich every Soil in every Clime.

How amiable is the Goodneſs, how amazing the Power, of the World's adorable Maker! How amiable his Goodneſs, in diſtributing ſo largely what is ſo extenſively beneficial? That Water, without which we can ſcarce perform any Buſineſs, or enjoy any comfort, ſhould ſtream by our Houſes, ſtart up from the Ground, drop down from the Clouds! Should come from the ends of the Earth, to ſerve us, from the Extremities of the Ocean! How amazing his Power! That this boundleſs Maſs of fluid Salt, ſo intolerably nauſeous to the Taſte, ſhould be the original Spring, which quenches the Thirſt both of Man and every

Animal! Doubtleſs the Power by which this is effected, can make *all things work together for* our *good.*

Vast and various are the Advantages which we receive from this liquid Element. The Waters glide on in ſpacious Currents, which not only chear the adjacent Country, but by giving a briſk Motion to the Air, prevent the Stagnation of the Vapours. They paſs by large Cities and quietly rid them of a thouſand Nuſances. But they are alſo fit for more honourable Services. They enter the Gardens of a Prince, float in the Canal, aſcend in the Jet d'eau, or fall in the grand Caſcade. In another kind, they ply at our Mills, toil inceſſantly at the Wheel, and by working the largeſt Engines, take upon them an unknown ſhare of our Fatigue, and ſave us both Labour, Time and Expence.

So forcibly do they act when collected. And how do they inſinuate when detached? They penetrate the minuteſt Tubes of a Plant, and find a paſſage thro' all its Meanders. With how much Difficulty does the Labourer puſh his way up the rounds of a Ladder? While theſe carry their Load to a much greater Height. and climb with the utmoſt Eaſe. They convey Nouriſhment from the loweſt Fibres that are plunged in the Earth, to the topmoſt twigs that wave amidſt the Clouds. Thus they furniſh the whole vegetable World with neceſſary Proviſion, by means of which *the trees of the* Lord *are full of ſap, even the cedars of Lebanon which he hath planted.* And notwithſtanding their vaſt Elevation and prodigious Diffuſion, not a ſingle Branch is deſtitute of Leaves, nor a ſingle Leaf of Moiſture.

Besides the ſalutary and uſeful Circulation of the Rivers the Sea has a Motion no leſs advantageous. Daily for five or ſix Hours, it *flows* toward the Land, and for the ſame time. *retires* to its inmoſt Caverns. How great is the Power that protrudes to the Shores ſuch an inconceivable Weight of Waters, without any concurrence from the Winds, often in direct Oppoſition to them? Which bids the mighty Element revolve with the moſt exact Punctuality? Did it advance with a lawleſs and unlimited Swell, it might deluge whole Continents. Was it irregular and uncertain in its Approaches, Navigation would be at a ſtand. But being conſtant in its ſtated Period, and never exceeding its appointed Bounds, it does no prejudice to the Country, and ſerves all the Ends of Traffick.

Is the Sailor returned from his Voyage? The *Flux* is ready to convey his Veſſel to the very Doors of the Owner, without any hazard of ſtriking on the Rocks or of being faſtened in the Sands. Has the Merchant freighted his Ship? The *Reflux* bears it away with the utmoſt Expedition and Safety. Behold O Man, how highly thou art favoured by thy Maker! *He hath put all things in ſubjection under thy feet. All ſheep and oxen, all the beaſts of the field: The fowls of the air, and the fiſhes of the Sea.* Yea the Surges of the Sea are ſubſervient to thee. Even theſe, wild and impetuous as they are, are ready to receive thy Load, and like an indefatigable beaſt of burden, carry it to the place which thou chuſeſt.

WHAT preſerves this vaſt Flood in perpetual Purity? It receives the Refuſe and Filth of the whole World. Whatever would defile the Land and pollute the Air, is tranſmitted to the Ocean. How then is this Receptacle of every Nuſance kept clean, kept from contracting a noiſom and peſtilential Taint? 'Tis partly by its inceſſant Motion, and partly by its Saltneſs. By the One it is ſecured from any internal Principle of Corruption; by the other it works itſelf clear of any adventitious Defilement.

CONSIDER the Sea in another Capacity, and it *connects* the remoteſt Realms of the Univerſe, by facilitating the Intercourſe, between their reſpective Inhabitants. The Antients indeed looked on the Ocean, as an impaſſable Gulph. But we find it juſt the reverſe; not a Bar of Separation, but the great Bond of Union. For this purpoſe it is never exhauſted, tho' it ſupplies the whole Earth with Rain: Nor ever overflows, tho' all the Rivers in the Univerſe are perpetually augmenting its Stores. By means of this we travel farther, than Birds of the ſtrongeſt Pinions fly. We croſs the flaming Line, viſit the frozen Pole, and wing our way even round the Globe.

What a multitude of Ships are continually paſſing and repaſſing this univerſal Thorough-fair! Whole Harveſts of Corn and Vintages of Wine, lodged in volatile Store-houſes, are wafted by the breath of Heaven, to the very Ends of the Earth: Wafted, enormous and unwieldy as they are, almoſt as ſpeedily as the Roe bounds over the Hills.

Astonishing, that an element ſo unſtable, ſhould bear ſo immenſe a weight! That the thin Air ſhould drive on with ſuch ſpeed thoſe vaſt Bodies, which the Strength of a Legion could ſcarce move! That the Air and Water ſhould carry to the diſtance of many thouſand Miles, what the united Force of Men and Machines could ſcarce drag a ſingle yard! *Great and marvellous are thy works,* O Lord God *Almighty!*

How are the Mariners conducted thro' this fluid Common, than which nothing is more wide or more wild? Here is no Tract, no Poſts of Direction, nor any Hut, where the Traveller may aſk the way. Are they guided by a Pillar of Fire? No, but by a mean, and otherwiſe worthleſs Foſſil 'Till this ſurprizing Stone was diſcovered, Ships crept timorouſly along the Coaſts. But this guides them, when nothing but Skies are ſeen above, and nothing but Seas below. This gives intelligence that ſhines clear in the thickeſt Darkneſs, and remains ſteddy in the moſt tempeſtous Agitations. This emboldens us to launch into the Heart of the Ocean, and to range from Pole to Pole.

By this means are imported to our Iſlands the choice productions of every Nation under Heaven. Every Tide conveys into our Ports, the Treaſures of the remoteſt Climes. And almoſt every private Houſe in the Kingdom, is accommodated from the four Quarters of the Globe. At the ſame time that the Sea adorns the Abodes of the Rich, it employs the Hands of the Poor. What a Multitude of People acquire a livelihood, by preparing Commodities for Exportation? And what a multitude, by manufacturing the

Wares imported from abroad? Thus tho' it is a falſe Suppoſition, that the Waters themſelves are ſtrained thro' ſubterranean Paſſages into the inland Countries, yet it is true, that their Effects are transfuſed into every Town, every Hamblet and every Cottage.

CHAP. II.

1. *Of the Effects and Nature of Fire:*
2. *Of the Generation and Nouriſhment of it:*
3. *Of Smoke and Aſhes:*
4. *Of Burning Mountains:*
5. *Of Earthquakes:*
6. *Of Glaſs:*
7. *Of the Nature and Properties of Air.*

1. THE *Effects* of *Fire* are various. It heats it ſhines, it expands, it diſſolves other Bodies, either by melting, or by reducing them to Aſhes or a Calx. Moſt of theſe argue a vehement Motion of its Particles, that tears aſunder wha ever it ſeizes. It ſeems to be a moſt ſubtle Matter, diſperſed throughout the Univerſe. Yet this even when collected ſoon ſcatters again, unleſs it be detained by ſome inflammable Matter. Not that Fire will ſpring from every Motion: It muſt be Circular, as well as rapid. For if Particles move ever ſo ſwift in a ſtrait Line, no Fire will follow.

Heat ſeems to be nothing but Motion: But this Motion has ſome peculiar Circumſtances. 1. It is *expanſive* Motion, whereby a Body endeavours to dilate itſelf. 2. This Motion is *upward*, and toward the Circumference: 3. It is not an equable Motion of the whole, but only *of the ſmaller Particles* of the Body: 4. It is a *rapid* Motion. Heat may therefore be defined, An expanſive, undulatory Motion in the minute

Particles of a Body, whereby they rapidly tend to the Circumference, and at the ſame time upward. [f]

2. Fire is *generated* chiefly, either by collecting the Sun-beams by a Glaſs, or by rubbing hard Bodies againſt each other. Either way the ſubtle Matter is collected from all ſides, and put into a rapid circular Motion. This continues together, as long as it is ſupplied with inflammable Subſtances. The Particles of theſe being divided by the Fire, are ſcattered hither and thither, and the Fire goes out, unleſs freſh Fewel be brought: As it does, if Air be wanting. For as that ſubtle Matter is diſſipating continually, it ſoon fails, unleſs recruited from the Air. If Water or Duſt be thrown upon Fire, it is likewiſe quickly extinguiſhed. For theſe interrupt that internal Motion, which is eſſential to it.

That Fewel cannot conſume without Air is clearly proved by an eaſy Experiment. Let a ſtrong hollow Cylinder of Iron, be fitted with a firm Screw at each End. Incloſe in this a piece of Charcoal: Then ſcrew up both Ends, and place it in a ſtrong Fire. Let it ſtay there as long as you will. Open it when cool, and the Charcoal is no way diminiſhed. It is plain from this, that the Conſumption of Fewel depends on the Rarefaction and Agitation of its Parts by freſh Air. And hence we have the Reaſon of the known Method, of extinguiſhing Fires by ſmothering them.

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[f] It ſeemes ſtrange, to talk of heating cold Liquors with Ice. Yet it may eaſily be done thus. Out of a Baſon of cold Water, wherein ſeveral Fragments of Ice are ſwimming, take one or two and plunge them into a wide mouthed Glaſs of ſtrong Oil of Vitriol. This quickly melts the Ice, and by 2 or 3 Shakes, the Liquor grows ſo hot, that frequently you cannot indure to hold the Phial in your hand.

It may ſeem as ſtrange, that thoſe Parts of the Earth, which are neareſt the Sun, ſhould be intenſely cold. Yet ſo it is. For the higher you aſcend on Mountains, the colder is the Air. And the tops of the higheſt Mountains in the moſt ſultry Countries, are eternally clothed with Snow. This is partly owing to the Thinneſs of the Air, partly to the little Surface of Earth there, to reflect the Solar Rays.

THE Sparks which appear on ſtriking Fire with a Flint and Steel, are diſcovered by the Microſcope, to be ſo many ſpherical Balls of Iron, detached by the Blow from the Maſs. They are then red hot. After they cool, they are a ſort of Scoriæ or Droſs.

3. THE watry Part of the Fewel, being rarefied by the Heat, aſcends in the form of *Smoke*, carrying with it many of the lighter Particles, which adhere as *Soot* to the Chimney. The groſſer and more compact, the Contexture whereof the Fire cannot wholly deſtroy, remain and conſtitute *Aſhes*, which is of conſequence extremely porous, all that was combuſtible in it being conſumed.[g]

THAT

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[g] To inlarge a little on this Subject. *Fire* is a Body, and a Body in motion. It is in motion; for it expands the Air; which can no otherwiſe be done, than by communicating Motion to it. And that it is a Body appears hence. Pure Mercury incloſed in a Phial, and kept in a gentle Heat for a Year, is reduced into a Solid. And its Weight is conſiderably increaſed, which can only ſpring from the Acceſſion of Fire.

FIRE is the inſtrument of all the Motion in the Univerſe. Without it all Bodies would become immoveable. Men would harden into Statues; and not only Water, but Air cohere into a firm, rigid Maſs.

As it is in itſelf, it is termed *Elementary Fire:* Joined with other Bodies it is called *Culinary*. The minute particles of this, joining with thoſe of the pure Fire, conſtitute what is termed *Flame*. Pure Fire, ſuch as is collected by a Burning-glaſs, yields no Flame, Smoke or Aſhes. In itſelf it is imperceptible, but is diſcovered by its *Effects*. The firſt of theſe is *Heat*, which ariſes wholly from Fire, and the meaſure of Heat is always as the meaſure of Fire. The 2d is *Dilatation* in all ſolid, and *Rarefaction* in all fluid Bodies. So an Iron Rod, the more it is heated, increaſes the more in all its Dimenſions. And by the ſame Degrees that it cools, it contracts, 'till it ſhrink to its firſt Magnitude. So Gold when fuſed, takes up more ſpace then it did before. And Mercury aſcends in an hollow tube over the fire, to above thirty times its former Height. The ſame Degree of Heat rarefies Fluids ſooner, and in a greater Degree than it does Solids. And the lighter the Fluid, the more it is dilated. Thus Air the lighteſt of all Fluids, expands the moſt. The Third Effect of Fire is *Motion:* for in dilating Bodies, it muſt needs move their Parts. All Motion ſprings from it. Only take Fire away, and all Nature would grow into one Concrete, ſolid as Gold and hard as Diamond.

4. That this ſubtle Matter is plentifully collected in the bowels of the Earth, appears from *Burning Mountains*. It is obſerved, that there is always in the neighbourhood of theſe, plenty of Sulphur or Bitumen, the Stench whereof ſpreads far and near, eſpecially before any great Eruption. This feeds the fire, which may be kindled by various means, ſo as to continue for many Centuries. *Ætna* and *Veſuvius* have burned for above 2000 years, and probably will, 'till the End of Time.

Pure Fire needs no Air to ſuſtain it. Put Calx of Tin into an exhauſted Receiver, and if you apply a Burning-Glaſs, the Calx will be ſo vehemently dilated, as to break the Receiver into a thouſand pieces.

All the Effects of Elementary Fire may be increaſed. 1. By rubbing one Body againſt another. And the more hard and ſolid the Bodies are, the more Heat is produced. So Sponges rubbed together acquire little or no Heat: But two pieces of Iron, an intenſe Heat. 2. By mixing certain Bodies together. So Steel-filings mixt with Oil of Cloves or Spirits of Nitre grow exceeding hot; yea burſt into a violent Flame.

Yet it does not appear that any new Fire is *generated* in any of theſe ways. Friction does not *create* Fire, but only *collect* what was before diſperſed. It is preſent every where, in all Bodies, in all Space, at all times, and that in equal Quantities. Go where you will, to the higheſt Mountain, or the deepeſt Cavern, by one or other of theſe ways Fire may be collected. Yea, there is no place in the World, where the Attrition of two Sticks will not make it ſenſible.

But in what manner ſoever Fire is collected, if the collecting Cauſe ceaſe, it diſappears again, unleſs it be ſupplied with Fewel, and then it becomes *Culinary* Fire. By *Fewel* we mean whatever receives and retains Fire, and is conſumed thereby. The only Fewel in Nature is Oil or Sulphur, and Bodies are only Fewel, as containing Oil. Hence 1. All Vegetables, not too moiſt or too dry afford Fewel, particularly thoſe which contain much Oil, as balſamic and reſinous Woods. 2. All vegetable and animal Coals, being thoſe Parts which have exhaled their Water and Salt, and retained the Oil alone inhering in their Earth: 3. All bituminous Earths, 4. All Mineral Sulphur, whether pure or joined with other things, 5. The Fat and Dung of Animals, and 6. Chymical Oil and Spirits.

On the removal of Air, this Fire goes out. Yet it does not immediately bear the Air, but repels it, and by that means forms a kind of Vault, which by its Weight and the Preſſure of the incumbent Air, confines the Particles that would otherwiſe eſcape, and applies them to the combuſtible Matter. Hence the heavier the

An Eruption of Mount *Ætna* in 1669 was preceded for Eighteen Days, with a dark, thick Sky, Thunder, Lightning, and frequent Tremblings of the Earth. The Place of Eruption was twenty Miles from the old Mouth: The Matter of it was a Stream of melted Minerals, boiling up and guſhing out, as Water does, at the head of a great River. Having run thus for more than a Stone's-caſt, the Extremities began to cruſt, and turn into porous Stones, reſembling huge Cakes of Sea-coal, full of a fierce fire. Theſe

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Air, the fiercer the Fire; which therefore is fierceſt in ſtill, cold Weather.

This Fire in burning combuſtible matter, affords a ſhining Fire, or Flame, or both: And frequently too, Smoke, Soot and Aſhes. *Shining Fire* ſeems to be Elementary Fire, ſo ſtrongly attracted toward the particles of the Fewel, as to whirl, divide and attenuate them, and thus render them volatile and juſt fit to be expelled. *Flame* ſeems to be the moſt volatile Part of the Fewel, greatly rarefied and heated red-hot. *Soot* is a ſort of Coal, conſiſting of a thick Sulphur, and an attenuated Oil, with Earth and Salt. *Smoke* is the earthy and watry Particles of the Fewel, ſo rarefied as to break thro' into the Atmoſphere. *Aſhes* are the Earth and Salt, which the Fire leaves unchanged.

Fire increaſes the Weight of ſome Bodies. Thus if Antimony be placed under a Burning glaſs, the greateſt Part of it will ſeem to evaporate in Fumes, and yet if it is weighed, it will be found to have gained in weight.

But beſide the Solar, there is a Subterraneous Fire. The Earth is only cold to the Depth of ſorty or fiſty feet. Then it begins to grow warmer; and at a great depth it is ſo hot as to deſtroy Reſpiration. Hence we learn that there is another Source of Fire, or as it were another Sun, in the boſom of the Earth.

Upon the Application of Fire to Water, it *boils*: that is, the particles of Fire, paſſing thro' the Pores of the Veſſel, ſtrike on the loweſt particles of the Water, impell them upwards, and render them lighter than before, both by inflating them into little Veſicles, and by breaking and ſeparating their Spherules. There will of conſequence be a conſtant Flux of Water, from the bottom of the Veſſel to the top. And hence we ſee, why the Water is hot, at the top ſooner than at the bottom. Farther, the Air contained in the Interſtices of the Water being dilated, and its Spring increaſed by the Heat, it aſcends thro' the Water into the Air, carrying with it the contiguous Particles of Water. And by this means much of the Water will be heaved up, and let fall alternately, as the Air has not power to carry away into the Atmoſphere, more than that ſmall Part that riſes in *Steam*.

Theſe came rolling over one another, and where any thing oppoſed, filled up the Space and rolled over. But they bore down any common Building, and burnt up all that was combuſtible. This Inundation went on about a furlong a day, for 19 or 20 days. It overwhelmed fourteen Towns and Villages. The Noiſe of the Eruption was heard Sixty Miles.

On Sunday, *March* 9, 1755, about Noon, Mount *Ætna* began to caſt from its mouth, a great quantity of flame and ſmoke, with a moſt horrible Noiſe. At four o'clock, the Air became quite dark and covered with black Clouds. At Six a ſhower of Stones, each weighing about three Ounces, began to fall over all the City of *Maſcali* and its territories. This ſhower laſted 'till a quarter paſt Seven; and was ſucceeded all night by a Shower of black Sand. On Monday Morning at Eight, there ſprung from the bottom of the Mountain, a river of ſcalding-hot Water, which in half a quarter of an hour overflowed all the rugged Land that is near the foot of the Hill, and ſuddenly going off, left the whole a large plain of Sand. The Stones and Sand which remain wherever this Water reached, differ in nothing from the Stones and Sand of the Sea, and have even the ſame Saltneſs. After the water was gone, there ſprung from the ſame Opening, a ſmall Stream of Fire, which continued for four and twenty Hours. On Tueſday, about a mile below this opening, there aroſe another Stream of Fire, which being in breadth about four hundred feet, overflowed all the adjacent Country.

On the 3d of *December*, 1754, a Stream of liquid Fire, began to run down the ſide of Mount *Veſuvius*, from an opening on the Eaſt-ſide. But it ſoon ceaſed running from this Orifice, and burſt out from a much larger one, about two hundred Yards below it. Afterward it burſt out from a third Orifice, and having run ſome ſpace with great fury, the Surface then began to cool and incruſt, as it ran over gently declining Ground, 'till it came within about ten yards of the top of a ſteep Declivity. Here the Fire collected, as in a Reſervior, to ſupply a Caſcade, which ruſhed down from thence, in a channel of more than 20 feet wide, and about 200 yards in length, with a fall of at leaſt fifty feet. After this the Stream was leſs rapid, but grew wider, and ſpread ſeveral miles from its Source. It now preſented a very different Scene, from what it afforded before. The Caſcade (ſays an Eye-witneſs) looks like melted Gold, and tears off large Bodies of old *Lava* (ſo they term the incruſtation) which float down the Stream, 'till the intenſeneſs of the heat lights them from the bottom. But in the lower Country, it divides into ſmaller Streams, running with leſs rapidity: And yet with ſuch violence, that it drives the ſtrongeſt ſtone-fences before it, and lighting the Trees, like Torches, affords a moſt extraordinary, tho' diſmal, Spectacle.

On *December* 23, 1760, about Two in the Morning, a violent Shock of an Earthquake was felt, near Mount *Veſuvius*. Some time after, ſome Countrymen being at work, four or five miles from it, perceived the ground near them on a ſudden heave and gape, like Dough that is riſing. At the ſame time, they obſerved Smoke iſſuing from the Clefts. They immediately fled, 'till they thought they were out of Danger: And then looking back, ſaw the Water of a Ciſtern, near which they had been at work, ſpout out to a great height. This was ſucceeded by a large Diſcharge of fiery Matter from the mouth of the Ciſtern, and from four other Openings, attended with a dreadful Noiſe and Exploſion of burning Stones. On a ſudden all the fiery Streams united in one, flowed impetuouſly down the Mountain, and gliding quick as Lightning, preſently covered all the adjacent Lands. Meantime the whole Mountain ſhook greatly, and a fixt Pillar of Smoke iſſued out of the main Aperture, which riſing to a certain Height, then diſſolved into Aſhes, and fell like Rain, all over the Mountain. At the ſame time an immenſe Quantity of burning Stones was thrown out.

The fiery Stream continued running down the Mountain, the whole Night between the 23d and 24th. Houſes, Gardens, and every thing in its way, were conſumed.

ſumed. And Aſhes were ſtill thrown out, which lay deep on the ground for ſeveral miles about, and reached as far as the Sea-coaſt.

On the 25th alſo there was an eruption of liquid fire, with a ſhower of Stones, and an huge Noiſe. In ſeveral Parts this Stream was fifty Spans deep. The Mountain meantime continued to roar, and thick Aſhes fell like Rain, over the whole Country.

On the 26th both the Mountain itſelf and the Hills lately produced, ſent forth Stones and Aſhes. The Bellowings were ſtill heard, but with Intermiſſions: And out of the five Apertures, two only continued to emit Stones and Aſhes and fire.

On the 27th only one fiery Stream remained, and that began to cool, and to loſe its Brightneſs, appearing more duſky, like burning Coals ready to go out. On the 28th the Stream ran much ſlower, and no more burning Stones were caſt out. The Height of the chief Hill raiſed thereby was about 200 Spans, and its Circumference about 200 Paces. The Motion of the Lava in front was very ſlow; it gained ground only on the ſides. The Hill, where the laſt Aperture was, burſt, and fire iſſued from all the Fiſſures.

On the 29th, the Lava having ceaſed, appeared to have reached about a mile in breadth and four miles in length. The new-raiſed Hills were now quiet: But the top of *Veſuvius* ſtill caſt out Aſhes and Smoke and ſome Showers of Stones. About Eight at Night the New Hill was overturned with a great Crack, and on the 30th emitted nothing. But from the mouth of *Veſuvius* Clouds and Aſhes came in great Abundance. From the whole it appears, that the inflammatory Contents take fire at a great Depth in the Cavern. And it is highly probable, it is the Sea-water which feeds this ſubterraneous Fire, by means of ſome Communications which the Volcano has with the *Mediterranean*.

There are Volcanos likewiſe in many of the *American* Iſlands: And a very eminent one in *Guadalupe*. The Summit of this conſtantly emits Smoke, and ſometimes Flames It riſes very high in the form of a Cone above the chain of Mountains, that occupy the Center of the Iſland. Near the foot of it are three Springs, the waters of which are ſo hot as to boil Eggs in three Minutes. The neighbouring Ground ſmokes and is full of brown Earth, like the droſs of Iron. But the chief Place where the ſmoke iſſues out, is higher up, at the foot of a ſteep bank, about 50 yards in breadth. Here no Graſs is to be ſeen; nothing but Sulphur and calcined Earth. The ground is full of deep Cracks, which emit much Smoke, and where you may hear the Sulphur boil. But the Stench of it is intolerable. The ground is looſe, ſo that you may thruſt a Cane up to the head. And when you draw it up, it will be as hot as if you had plunged it into Slaking Lime.

On the plain top of the Hill is another Funnel, that opened ſome years ſince, and emits nothing but Smoke. But here are abundance of large and deep Chinks, which doubtleſs burned in former times. In the middle of this plain is a very deep Abyſs. It is ſaid, there was once a great Earthquake in the Iſland, and that the *Brimſtone-Hill* (ſo they call it) then took fire. It was probably then, this Abyſs was opened. It is between two Crags that riſe above the Mountain, and on the North ſide anſwers to the great Cleft, which goes down above a thouſand feet perpendicular, is more than 20 feet broad and penetrates above 100 paces into the flat. So that in this place the Mountain is fairly ſplit, from the top down to the Baſis of the Cone.

On this Plain you may ſee the Clouds gather below, and hear the Thunder rumble under your feet. The great Cavern is under the Cleft, and was doubtleſs formed by the ſame Earthquake that ſplit the Mountain into two Parts nearly equal. The Parting goes North and South. To the North is the Cleft and the Cavern, in the middle the Abyſs, and to the South, the burning Gulph. The Cavern is about twenty-five feet wide, as much in height, and about ſixty Paces deep. Within this is a ſecond Cave, about 60 feet in length, as much in breadth, and forty in height. Here the Heat is moderate: But there is a third Cave within this, where it is ſo hot, that a torch will give no Light therein, and a man can ſcarce fetch breath. Yet on the left is a great hollow, which is ſufficiently cool. And the ſpace of One fathom makes the difference. It ſeems ſtrange, that in the ſame Cave, 300 feet under ground, it ſhould be ſo hot on one ſide, and ſo cool on the other. Perhaps the cool Side has ſome Vent into the great Cleft, and receives freſh Air thereby.

ANOTHER ſurprizing Eminence, which may be ranked among burning Mountains, is the *Pike* of *Teneriff*. On the Summit of it is an Hollow twelve or fourteen feet deep: The Sides ſloping down to the bottom, form a Cavity, like a truncated Cone, with its Baſe uppermoſt. This Cavity is nearly circular, about forty fathoms acroſs. The Ground is very hot, and from near twenty Veins, iſſues a Smoke of a ſtrong, ſulphureous Smell. The whole Soil ſeems powdered with brimſtone, which forms a beautifully coloured Surface. Almoſt all the Stones thereabouts are of a greeniſh Colour, ſparkling with yellow, like Gold. On the middle of one of the Rocks is an hole, about two inches in diameter. Hence prodceeds a noiſe, like that of a great Body of Liquors boiling very ſtrongly. And ſo hot a ſteam comes from it, as will burn the hand, even at a quarter of a yard's diſtance.

A SMALL Part of the Sugar-loaf is white like Lime: Another ſmall Part is covered with a Salt. But the far greateſt Part is covered with Snow, almoſt throughout the Year.

THE Accounts given of its height are exceeding various: But a Gentleman ſome years ago, who meaſured it exactly, found the perpendicular Height to be two thouſand, five hundred and ſixty-ſix fathoms.

5. WHEN it happens that any inflammable Subſtance takes fire in the Caverns of the Earth, the Air contained therein is rarefied and exploded with an immenſe Force. Hereby not only the Arch which covers it, but the whole Body of incumbent Earth is ſhaken. And this is one Species of *Earthquakes*. In this caſe, the deeper the Cavern is, and the larger the Quantity of matter which takes fire, the more extenſive and the more violent the Earthquake. If the Cavern is near the Surface of the Earth, the Fire often iſſues out of it; and the lower

Parts being eaten away, the Ground ſinks in and ſwallows up Houſes or whole Cities. But, to conſider this point a little more minutely. As ſome Earthquakes are owing to Fire, ſo are ſome to Air, others to Water, and others to Earth itſelf. 1. The Earth itſelf may be the occaſion of its own ſhaking, when the Roots or Baſis of ſome large Maſs being worn away, that Maſs ſinks in by its own weight, and cauſes a Concuſſion of all the neighbouring Parts. 2. Subterraneous Waters waſh away the foundations of Hills, and eat far under the Earth. By this means many Earthquakes have been occaſioned, and whole Cities ſwallowed up. This was undoubtedly the Cauſe of the great Earthquake at *Port-royal*, and of that which ſwallowed up *Lima*. 3. Air pent up in the Bowels of the Earth, if it be at any time rarefied and expanded, will ſtruggle for vent with incredible force, and thereby both ſhake and tear the Earth. 4. But the uſual Cauſe of the moſt violent Earthquakes is Sulphur, or ſome other inflammable Matter, taking fire in the Cavities of the Earth, and burſting thro' whatever oppoſes.

THERE are ſcarce any Countries that are much ſubject to Earthquakes, which have not ſome burning Mountain. And whenever any Earthquake happens, this is conſtantly in flames. Indeed were it not that theſe Vents thus diſgorge the Fire, it would make far greater Havock than it does; probably, it would make the whole Country for a vaſt ſpace round, quite uninhabitable. Yea ſo beneficial are theſe, that we do not want Inſtances, of Countries frequently annoyed by Earthquakes, which upon the breaking out of a Volcano, have been wholly delivered from them.

PERHAPS what cauſes moſt Earthquakes of this kind is the *Pyrites*, or Iron-ſtone, which will take fire of itſelf. The Earth, we know, abounds in Cavities, which are at certain times full of inflammable Vapours. This the Damps in Mines ſhew, which being fired, do every thing as in an Earthquake, only in a leſs degree. And the Pyrites only, of all known Minerals, yields this inflammable Vapour. Nor is any Mineral or Ore whatever ſulphureous, but what is more or leſs mixt with the

Pyrites. But probably the Pyrites of the burning Mountains, is more ſulphureous than Ours. It is likewiſe in far greater Quantities in all the Countries round the *Mediterranean* than in *England:* A plain Reaſon why Earthquakes are ſo much more frequent and more violent there.

An artificial Earthquake may be made thus. Add 20 pounds of Sulphur to twenty of Iron Filings. Mix and temper theſe with Water, ſo as to form a maſs of the conſiſtence of a firm Paſte. Bury this three or four feet under ground. In Six or ſeven Hours time, the Earth will begin to tremble, crack and ſmoke, and Fire and Flame will burſt thro'. So that there only wants a ſufficient Quantity of this Matter, to produce a true *Ætna.* If it were ſuppoſed to burſt out under the Sea, it might occaſion a New Iſland.

To explain this point a little farther. This Globe of Earth is bored thro' with infinite Cavities, which branching out, like the Veins, Arteries and Nerves in our Bodies, paſs under the very bottom of the Sea. Some of them ſerve to convey Water, others a more unctuous Subſtance, others an igneous Matter, that gives Motion to the whole Frame.

Thus the exterior Sea communicates with the inmoſt Abyſs, and paſſes to the Roots of the Hills and Mountains. Meantime a conſtant Air or Wind forces the Water into the dark Caverns, and revives and keeps alive a perpetual Fire.

Have we not indubitable Examples of theſe things? Does not the vaſt River *Wolga,* pour ſuch a Quantity of Water into the *Caſpian,* within the ſpace of one Year, as would be ſufficient, were there not ſome inviſible Outlet, to cover the whole Earth? This inviſible Outlet is an huge Cavern, that paſſes under Mount *Caucaſus* into the *Euxine Sea.* Hereby the Waters of the one Sea, diſcharge themſelves into the other. And the whole Kingdoms of *Georgia* and *Mengrelia,* are as it were a Bridge over thoſe ſubterraneous Waters.

When the *Caſpian* Sea has been, on occaſion of winds, too much emptied into the *Euxine,* it is repleniſhed from the *Perſian Gulph,* which is a kind of Reſervior for it.

And the ſubterraneous Communication between the *Red Sea* and the *Mediterranean*, is now out of all diſpute.

And how many Inſtances of this have we in *Rivers*? So late Geographers aſſure us, that the River *Niger* in *Afric* is derived from the River *Nile*, under the mighty Chain of the Mountains of *Nubia*; on the Weſtern Side of which Mountains, it takes the name of *Niger*, and continues its courſe into the *Atlantic* Ocean. So the vaſt and deep Cave in Mount *Taurus*, receives the *Tigris* and gives it a paſſage to the other ſide. The ſame River afterward hides itſelf under ground, for near 12 Miles, and then breaking out again, diſembogues into the *Euphrates*, near *Babylon*.

To come nearer home: The *Guadiana*, that runs between *Spain* and *Portugal*, runs thirty two miles under ground. Yea, in our own Country, the *Mole* in *Surry*, falls into the ground near *Boxhill*, and riſes again at a conſiderable Diſtance.

Hence we may ſafely collect, that the Earth is filled with ſubterraneous Aqueducts and Caverns, full of Air and Vapour and copious Exhalations from all ſorts of Minerals, as well as Water.

Besides theſe Cavities, there are Mountains whoſe Bowels are in a continual Flame. And their belching out Aſhes, Smoke, broken Rocks and Minerals, argue vaſt Vacuities, and huge Magazines of combuſtible matter, which are lodged therein. In the Chain of Mountains called the *Andes* in *America*, there are no leſs than fifteen Volcanos, by whoſe Burnings, Caverns, as big as whole Kingdoms are made, and receive the Cataracts of mighty Rivers. And not only here, but over all the Earth, there are ſo many Channels, Clefts and Caverns, that we do not know, when or where we ſtand upon good ground. Indeed it might amaze men of a ſtout Heart, could they ſee into the World beneath their feet, view the dark Receſſes of Nature, and obſerve that the ſtrongeſt Buildings ſtand upon an immenſe Vault, at the bottom of which runs an unfathomable Sea, and whoſe upper Hollows, are filled with ſtagnating Air and the Expirations of ſulphureous and bituminous Matter.

THEREFORE as there are no large Tracts of Land, without Volcanos and ſulphureous Caverns, from which branching into ſmaller Pipes, the ſubterraneous Heat is conveyed throughout the Earth: So no Country can promiſe itſelf an entire Immunity from Earthquakes: Even were there no other Cauſe of theſe dreadful Events, but ſubterraneous Fires. Eſpecially when it is conſidered, that the Earth is in one Part impregnated with Sulphur, in others with Nitre, Allum, Vitriol, Mercury, Bitumen, Oker and Chalks. For if an artificial Powder, made only of Nitre, Sulphur and Charcoal, has ſo wonderful Effects: What force muſt that combuſtible Matter have, which ariſes from Sulphur, Nitre, Sal Ammoniac, Bitumen, Gold, Copper, Iron, Arſenic, Mercury, and other metallic and mineral Spirits, with which the Womb of the Earth abounds, when the ſubterraneous Fires break thro' into the hollow Vaults, where theſe are repoſited by the GOD of Nature? Then, according to the Copiouſneſs of theſe Combuſtibles, and the more or leſs Firmneſs of the ſuperincumbent Earth, theſe Fires cauſe Tremblings and Concuſſions, or violent Eruptions: And perhaps open wide and deep Gulphs, wherein whole Cities, yea Mountains are ſwallowed up.

MANY ſuch Inſtances occur in Hiſtory. *Pliny* tells us, that in his own time, the Mountain *Cymbotus*, with the town of *Eurites*, which ſtood on its ſide, were totally ſwallowed up. He records the like of the City of *Tantalis* in *Magneſia*, and after it, of the Mountain *Sopelus*, both abſorbed by a violent Opening of the Earth, ſo that no trace of either remained. *Galanis* and *Garnatus*, towns once famous in *Phœnicia*, are recorded to have met the ſame fate. Yea, the vaſt promontory called *Phlegium* in *Æthiopia*, after a violent Earthquake in the night, was not to be ſeen in the Morning, the Earth having ſwallowed it up and cloſed over it.

LIKE Inſtances we have of later date. The Mountain *Picus*, in one of the *Molucca's*, was ſo high that it appeared at a vaſt diſtance, and ſerved as a land-mark to Sailors. But during an Earthquake in the Iſle, the Mountain in an inſtant ſunk into the bowels of the Earth: And no token of it remained, but a vaſt Lake of Water. The like happened in the mountainous Parts of *China*, in 1556: When a whole Province, with all its towns, Cities and Inhabitants was abſorbed in a moment; an immenſe Lake of Water remaining in its place, even to this day.

In the year 1646, during the terrible Earthquake in the kingdom of *Chili*; ſeveral whole Mountains of the *Andes*, one after another, were wholly abſorbed in the Earth. Probably many Lakes of whoſe beginning we have no account, were occaſioned by the like Abſorptions.

In *Perſia*, there is a ſubterraneous Fire, of a more harmleſs Nature. It riſes out of the ground, about twenty miles from *Baku*, and three from the *Caſpian* Sea. The Ground is rocky, but has a ſhallow Covering of Earth. If this be any where ſcraped off, and fire applied to the place, it catches fire immediately, and burns without diminution, nor ever goes out, unleſs you throw cold Earth over it, by which it is eaſily extinguiſhed. A piece of Ground, about two *Engliſh* Miles in Extent, has this wonderful Property. In many Parts of it there is a continual Flame: The chief is an hole about four feet deep and fourteen in diameter. This is ſaid to have burned many thouſand Years. They burn Stones into Lime, by filling a hole in the ground with them, and then bringing a lighted Candle to the hole. The fire immediately kindles, and in about three days, burns the Stones ſufficiently.

It is remarkable, that this Flame, how great ſo ever it be, gives neither Smoke nor Smell. There is much Napththa all about the place, tho' not juſt where the Fire is.

Doubtless an inflammable Vapour iſſues in abundance out of the ground in this place. Something of the ſame kind is found between *Bologna* and *Florence*, on the ſide of one of the *Appennines*. On a ſpot of ground three or four miles in diameter, there is a conſtant Eruption of Fire. The Flame riſing very high; yet without Noiſe, Smoke or Smell. In great Rains it ſometimes intermits, but afterward burns with the greater Vigour. There are three other ſuch Fires on the ſame Mountains. Probably they riſe from Veins of Bitumen.

We have the like inflammable Vapours in *England*, in three or four different Places. In *Dauphiny* and ſome other Parts of *France*, the Surface of ſeveral Springs takes fire in the ſame manner on the Approach of a Candle. Sulphureous Vapours undoubtedly exhale from the Waters: As is the Caſe in the famous *Grotto del Cani*.

This lies on the ſide of a little Hill, between *Naples* and *Pozzoli*. The ſides of it are cut perpendicular in the Earth. It is about three feet wide; near twelve feet long; five or ſix feet high at the Entrance, and leſs than three at the farther End.

The Ground ſlopes a little from this End to the Mouth, and more from thence to the road. If you ſtand a few ſteps without, and ſtoop ſo as to have your eye nearly on a level with the ground of the Grotto, you may ſee a Vapour within, like that which appears over a Chafing-diſh of red-hot Coals, only that it is more ſluggiſh, and does not riſe above five or ſix inches high. Its Surface, more diſtinctly terminated than that of other Vapours, balances viſibly under the Air, as if unwilling to mix with it. The Ground of the Grotto is always moiſt; and ſo are the Sides to the height of ten inches. Yet this never increaſes ſo as to form any drops. While you ſtand upright, you remark nothing more, than a ſlight earthy Smell, common in all ſubterraneous places which are kept ſhut. But if you put down your hand, within ten inches of the ground, it feels as if you put it into the ſteam of boiling Water. Yet your hand contracts neither Smell nor Taſte. A Vapour ſimilar to that in the Grotto, riſes alſo from the ground without. But it is weaker, and does not riſe ſo high. This partly ſpreads itſelf from the Cavern, partly exhales from the Earth.

A lighted Flambeau, thruſt into the Vapour, preſently goes out; yet without any Noiſe or Hiſſing. The thick Smoke which appears immediately after its Extinction, remains floating on the Vapour, and being lighter than it, but heavier than the Air above it, ſpreads between both. Indeed Common Smoke is lighter than Air: but that impregnated with the Vapour is heavier.

If a young vigorous Dog be held down within the Vapour, he at firſt ſtruggles, pants, ſnorts and rattles in the throat. But in three Minutes he lies as dead. Carry him into the open Air, and he draws in long Draughts, as one recovering from a Fit, and in two Minutes gets upon his Legs, and ſeems to ail nothing. A Cock having his Head plunged into the Vapour, was ſuffocated all at once beyond recovery. Frogs are ſtupified by it in 3 or 4 minutes: yet tho' they have laid in it a quarter of an hour, ſoon recover when placed in the open Air. Large Flies, Beetles and Butterflies, were longer without giving Signs of their ſuffering, and longer in recovering. A Toad reſiſted the Vapour near half an Hour, a Lizard above an hour and a Quarter. And a large Graſs-hopper ſtirred in the Vapour, after being more than two Hours in it.

An *Engliſh* Gentleman kneeled down in the Grotto, and leaning on his hands, bowed his face to within 2 or 3 inches of the ground, holding his breath, keeping his eyes open, and his Tongue a little out of his mouth. He remained thus three or four Seconds, without any painful impreſſion, or any ſort of Taſte on his Tongue. And hence it manifeſtly appeared, that this is not a poiſonous Vapour.

He afterward advanced his face to the Surface of the Vapour, and took in breath gently. He was ſenſible of ſomething ſuffocating, juſt like the Air of an hot and moiſt Stove. Likewiſe he felt a ſlight acrimony in the throat and noſe, which made him cough and ſneeze: but no Head-ach, no Sickneſs at Stomach, nor any other Inconvenience.

It is clear then upon the whole, that Animals die in this Vapour, not as poiſoned, but rather as drowned, in a fluid not capable of ſupplying the place of the Air which is neceſſary for Reſpiration, and equally neceſſary to ſuſtain Fire, as the Flame of a lighted Flambeau.

A much ſtranger Flame than that which iſſues out of Earth, is that which iſſues out of the Stomach of Animals. The Anatomical Lecturer at *Piſa* in the year 1597, happening to hold a lighted Candle near the Subject he was diſſecting, on a ſudden ſet on Fire the Vapours that came out of the Stomach he had juſt opened. In the ſame Year, as Dr. *Ruiſch*, then Anatomy-Profeſſor at *Piſa*, was diſſecting a Woman, a Student lighting him with a candle, he had no ſooner opened the Stomach, than there iſſued out a yellow, greeniſh Flame. A like thing happened ſome years after at *Lyons*, in diſſecting a Woman. Her Stomach was no ſooner opened, than a conſiderable Flame burſt out and filled the place. But this is not ſo much wondered at, ſince the Experiments made by Dr. *Vulpari*, Anatomical-Profeſſor at *Bologna*. He affirms, any one may ſee, iſſuing from the Stomach of an Animal, a matter that burns like Spirits of Wine, if the upper and lower Orifices are bound faſt with a very ſtrong Thread. The Stomach thus tied muſt be cut, above and under the Ligature, and afterward preſt with both hands, ſo as to make all that it contains, paſs to one ſide. This will produce a ſwelling in that part, which muſt be held with the left hand to hinder its eſcaping. A Candle then being held about half an inch from the Stomach, let it be ſuddenly opened by the right-hand, and a bluiſh Flame will immediately guſh out, which will ſometimes laſt a Minute. The ſame way Flame may be brought forth, from the Inteſtines alſo.

NOR is it from Carcaſes only that Flames have iſſued. This has been the caſe with live Perſons likewiſe. *Bartholine* relates, that a *Poliſh* Cavalier, having drank a quantity of Brandy, died in a little Space, after an Eruption of Flames thro' his Mouth. He relates alſo the caſe of three others, who after drinking much Brandy, experienced the ſame Symptom. Two preſently died; the Third eſcaped by immediately drinking cold Water. Still more aſtoniſhing is the Caſe of a Woman at *Paris*, who uſed to drink Brandy to exceſs. She was one night reduced to Aſhes by a fire from within, all but her Head and the ends of her fingers. In like manner *Cornelia Bandi*, an aged Lady of unblemiſhed Life, near *Ceſena* in *Romagna*, in 1731, retired in the Evening into her Chamber; and in the

Morning was found in the middle of the room, reduced to Aſhes, all except her Face, Scull, three Fingers and her Legs, which remained entire, with the Shoes and Stockings on. The Aſhes were light: the Floor was ſmeared with a groſs, ſtinking Moiſture, and the Walls and Furniture covered with a moiſt Soot, which had ſtained all the Linen in the Cheſt.

THERE have been Inſtances of ſeveral other Perſons, burnt to death in this unaccountable manner: One of whom was *Grace Pet*, of *Ipſwich*, in 1744.

6. THERE is no Body but may be by Fire converted into *Glaſs*: not excepting Gold itſelf. And this is the laſt Effect of Fire: No Art can carry the Change of a natural Body any farther.

AS to the Nature and Properties of it, 1. Common Glaſs is an artificial Compound of Salt with Sand or Stones. 2. It is fuſible by a ſtrong fire, and when fuſed is tenacious and coherent. 3. It does not waſte in the Fire. 4. When melted it cleaves to Iron. 5. When red-hot it is faſhionable into any ſhape, and capable of being blown into a hollowneſs, which no Mineral is. 6. It is frangible when thin, friable when cold, and tranſparent, whether hot or cold. 7. It is flexible, elaſtic and diſſoluble by Cold. 8. It can be cut only by Emery or a Diamond. 9. It is not diſſoluble by *Aqua-fortis*, *Aqua Regia* or *Mercury*. 10. Neither Acids nor any thing elſe extract Colour, Taſte, or any ſenſible Quality from it. 11. It loſes nothing either of its Subſtance or of its Weight, by the longeſt and moſt frequent Uſe. 12. It is not capable of being calcined, neither of contracting Ruſt.

BUT there is no Property of Glaſs more remarkable than its Ductility. Glaſs-Spinners draw Threads of their brittle Matter, melting over a Lamp, with far more Eaſe and Expedition, than common Spinners do thoſe of Flax or Silk. Theſe may be drawn fine as a Hair, yea as the threads of a Spider's Web, ſo as to wave with every wind. And the finer they are, the more flexible. If the Ends of two ſuch threads be knotted together, they may be drawn and bent, till the ſpace in the middle of the knot does not exceed the forty-eighth Part of an Inch in diameter.

THERE is ſomething aſtoniſhing in the Power of *Teleſcopes*, to bring far diſtant Objects near; and of *Microſcopes*, to render thoſe clear and diſtinct, which are quite inviſible to the naked Eye. And no leſs amazing in another kind, is the force of *Burning-glaſſes*. 1. A piece of Wood laid before a large Burning-glaſs, took fire in an inſtant. 2. Water contained in an earthen Veſſel boiled immediately, and in a ſhort time quite evaporated. 3. A maſs of Lead, three inches thick, began to melt in a moment, and ſoon after ran in a continued thread. 4. A Steel-plate grew red-hot almoſt in an inſtant, and ſmall holes were made thro' it. 5. Slate becomes black Glaſs, Tiles, Yellow Glaſs, Earthen-pots, a darkiſh-yellow Glaſs. 6. A Pumice Stone became white Glaſs, Earth black Glaſs, Bones, an opake one.

BUT in the extremely hot Weather at *Paris* in 1705, the Rays of the Sun collected by a large Glaſs, had ſcarce any force, tho the ſeparate Rays quite inflamed the Air. The Reaſon of ſo ſurprizing a thing ſeems to be, that the Heat raiſed from the Earth great ſulphureous Exhalations, which embarraſed, ſtopped, and in ſome degree abſorbed the Rays of the Sun.

Gunpowder is commonly ſuppoſed to have been invented by *Barthold Schwartz*, about the Year 1380. But *Roger Bacon* knew of it, an hundred and fifty years before *Schwartz* was born. For in his Treatiſe *de Nullitate Magica* publiſhed at *Oxford* in 1216 are theſe words. "You may raiſe Thunder and Lightning at pleaſure, by only taking Sulphur, Nitre and Charcoal, which ſingle have no effect, but mixt together and confined in a cloſe place, cauſe a Noiſe and Exploſion greater than that of a Clap of Thunder."

THE Effect of Gunpowder is owing to the Spring of the Air, incloſed in the Grains and in the Spaces between them. All theſe Springs are dilated by the Fire and ſet a playing at once. The Powder itſelf only ſerves to light the Fire, which puts the Air in action.

Aurum fulminans, a preparation of Gold, is far ſtronger than Gunpowder. A Scruple of this acts more forcibly than half a pound of That. A ſingle Grain laid on a knife and lighted at a Candle, goes off with a greater Noiſe than a Muſket.

7. *Air* is a *tranſparent* Body wherein we live, and which ſurrounds the Earth on every ſide. It is *liquid* too, and invariably ſo; for it cannot be frozen like Water. The eaſy Paſſage of Bodies thro' it, proves its Fluidity. And if a little light be let into a darkened Room, its Parts appear in a continual Fluctuation.

ANOTHER Property of Air is its *Weight* or *Gravity*. This you will immediately feel, if you lay your hand on the Mouth of a Veſſel, which is emptied of Air. If you lay a Square piece of Glaſs on the Orifice of an *Air-pump*, when the Air is drawn out, it will be broke to ſhivers with a great Noiſe. Or extract the Air from between two ſmoothly-poliſhed Marbles, and cloſe the Edges with Wax. They will then be ſo ſtrongly preſt together, as not eaſily to be ſeparated. But we need no other Proof of it than the *Barometer*: A Glaſs-tube, cloſe at one End, and filled with Mercury. Immerge the other End in a Baſon of the ſame Fluid, and when it is erected, the Mercury in the tube will riſe thirty Inches, above the Surface of that in the Baſon.

THE Changes then in the Barometer are wholly owing to the Changes in the Weight of the Atmoſphere. But to what are theſe owing? It ſeems, chiefly to the Winds. For 1. Theſe muſt alter the Weight of the Air in any particular Place, either by bringing together and accumulating the Air, which is the caſe when two Winds blow at the ſame time from oppoſite points: Or by ſweeping away Part of the Air, as when two Winds blow oppoſite ways from the ſame point; or laſtly, By cutting off the preſſure of the Atmoſphere, which happens when any Wind blows briſkly any way. 2. Cold, nitrous Particles load the Atmoſphere, and increaſe its weight: 3. So do heavy, dry Exhalations from the Earth. 4. The Air being rendered heavier

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is more able to ſupport the Vapours, which being intermixt with it, make the Weather fair and ſerene. When it is rendered lighter by the contrary Cauſes, it becomes unable to ſupport the Vapours, which then ſink, gather into drops and fall in Rain.

WITH us the Mercury is higheſt when the Wind is North or North Eaſt, and ſo brings the cold, condenſed Air of the Northern Climates. In all Northern Countries the Mercury varies more than in the Southern, the Winds being more frequent, ſtrong, various and oppoſite to each other. Between the Tropics it ſcarce varies at all, the Winds being ſmall and generally blowing the ſame way.

THE Preſſure of the Air, is *cæteris paribus*, as its Height. Carry the Barometer to an higher place, where the incumbent Column of Air is ſhorter, and a ſhorter Column of Air is ſuſtained: It being found to deſcend at the rate of a quarter of an inch for every hundred feet of Aſcent.

Now Air, as all other Fluids, muſt preſs equally every way. Hence it is, that ſoft Bodies ſuſtain their preſſure, without any Change of Figure, and brittle Bodies without breaking, tho' that preſſure be equal to that of a Column of Mercury, 30 inches high, or a Column of Water, of 30 foot. Nothing can keep theſe Bodies unchanged, but the equable Preſſure on all ſides, which reſiſts as much as it is reſiſted. And hence on removing or leſſening that preſſure on one ſide, the effect of it is ſoon perceived on the other.

IT is by means of its Gravity, 1. that the Air cloſely inveſts the Earth with all the Bodies on it, and bends them down: that it prevents the Arterial Veſſels of Plants and Animals from being too much diſtended, by the Impetus of the circulating Juices: and that it hinders the Blood from oozing out, thro' the Pores of their containing Veſſels. Hence they who travel up high Mountains, the higher they aſcend, are relaxed the more, till they fall into ſpitting of Blood. 2. The mixture of contiguous Fluids is chiefly owing to this. Hence many Fluids which readily mix in the Air, when that is removed, remain ſeparate. 3.

It determines the Action of one Body upon another. Thus it preſſes the Particles of Fire againſt the Fewel: Whereas upon removing the Air, the Fire immediately goes out. So *Aqua Regia* ceaſes to diſſolve Gold, if the Air be taken away: Hence alſo on the tops of high Mountains, as on the *Pike* of *Teneriff*, the moſt acrid Bodies, ſuch as Pepper, Ginger, Salt, have no ſenſible Taſte; for want of a ſufficient Gravity in the Air, to preſs their Particles into the Pores of the Tongue.

The Fourth Property of Air is *Elaſticity*. It yields to an impreſſion, by contracting its Dimenſions, and returns to them, on removing the impreſſive Cauſe. This Endeavour to expand itſelf, every Particle of Air continually exerts, againſt an equal Endeavour of the ambient Particles. Hence it is, that a Bladder full of Air, will burſt in an exhauſted Receiver: While one that before ſeem'd empty, ſwells and appears to be full of Air.

This Power does not ſeem to have any Bounds. Nor is it eaſy to be deſtroyed. Let Air be expanded ever ſo much, it ſtill retains its Spring. Nor is this ſenſibly diminiſhed by any Experiment, which has been yet made.

There is no fixing any Bounds to its Condenſation, any more than to its Dilatation. It will dilate into 10000 times its former Space, yea into 13679 times. And all this by its own expanſive Force, without any Force of Fire. The Air we breathe near the Surface of the Earth is compreſt by its own weight, into at leaſt the 13679th Part of the Space it would poſſeſs *in vacuo*. And if the ſame Air be farther condenſed by Art, the Space it will take up when moſt dilated, will be (according to Mr. *Boyle*) to that it poſſeſſes when moſt condenſed, as 550000 to one. By its Elaſticity Air inſinuates into the Pores of Bodies, carrying with it this Faculty of Expanſion; whence it muſt neceſſarily put all the Particles it is mixt with, into perpetual Oſcillations. And as its Elaſticity is never the ſame for two moments together, there muſt be an inceſſant Dilatation and Contraction in all Bodies. To this is owing all Putrefaction and Fermentation, neither o which will proceed *in vacuo*. And indeed all Natural Corruption and Alteration ſeem to depend hereon: So that Metals, particularly Gold, are ſo durable, only by being impervious to Air. And yet it may be doubted, whether Air itſelf be the true, original, univerſal Diſſolvent; or rather the ethereal Fire, which is intimately united with every Particle of it; and without which Air is effete and uſeleſs, neither able to feed Flame, nor to ſuſtain animal Life.

THAT there is ſome Matter in the Air much finer than the Air itſelf, appears from many Conſiderations. In an exhauſted Receiver ſomething remains, which conveys the Heat near as readily as Air. Now this muſt be a Body, and a Body ſubtle enough to penetrate the Pores of Glaſs. Doubtleſs then it penetrates the pores of all other Bodies, and conſequently is diffuſed thro' the Univerſe. And this ſeems to be not only more ſubtle than the Air, but far more weighty and elaſtic. To the Weight of this may be owing the Weight of the Air, and of all other Bodies: To its Elaſticity, the Elaſticity of the Air and of all other elaſtic Bodies. This alſo may cauſe the Reflection and other Phænomena of Light; as alſo Senſation and Muſcular Motion. Indeed it ſeems to be the firſt Spring of all the Action in the Univerſe.

AIR is ſometimes deprived of its Elaſticity, and wrought into the Subſtance of other Bodies, from which nevertheleſs it may be extracted and reſume its elaſtic State. As to *Animal Subſtances*, a very conſiderable Quantity of Air is extracted from them by *Diſtillation*, not only from the Blood and Fat, but alſo from the moſt ſolid Parts of Animals. Half a cubic Inch of a *fallow-deer's horn*, produced 117 cubic Inches of Air: Half a cubic Inch of *Oyſter ſhells*, no leſs than 162 cubic Inches.

As to *Vegetable Subſtances*, half a cubic Inch of *heart of Oak* generated 108 cubic Inches: A cubic Inch of *Peas*, 396 cubic Inches, or 113 grains, which was above a third of its Weight. This Air will flaſh, if touched with a Candle.

Camphire generates no Air: *Brandy*, next to none: *Well-Water*, or *Rain-water*, a little: *Pyrmont-Water*, twice as much; Which Air contributes to the Briſkneſs of this and other mineral Waters.

FROM Minerals much Air may be extracted Half an inch of *Newcaſtle Coal* yielded 180 inches of Air, which weighed near one third of the Coal.

YET a good Part of the Air extracted from theſe Bodies, in ſome days gradually loſt its Elaſticity: Becauſe the acid, ſulphureous Fumes, raiſed with that Air, reſorbed and fixt the elaſtic Particles. But when a means was found to prevent this, it loſt only a ſeventeeth or eighteenth Part: (and that chiefly in the firſt 24 Hours) The reſt was permanently elaſtic.

THERE is another way of producing Air, which ſeems to be more Natural, namely by *Fermentation*. A cubic inch of [h] *Oil of Vitriol* with half an inch of *Sal Ammoniac* generated Six cubic Inches of Air: Six Inches of powdered *Oyſter ſhells*, and an equal Quantity of *White wine Vinegar*, generated twenty-nine Inches.

THAT much Air is incorporated into the Subſtance of *Vegetables*, appears from the following Experiments.

FORTY two inches of *Ale* from the Tun generated in three Months 639 cubic Inches of Air: Twelve inches of *Malaga-Raiſins*, in ſix Weeks generated 411 inches: Twenty ſix inches of *Apples*, in thirteen Days generated 968 Inches of Air. They then in three or four days reſorbed about twelve inches, and afterwards neither generated nor reſorbed.

THAT the Air ariſing from diſtilled or fermenting Bodies, is true Air, appears from hence, that it continues in the ſame expanded State for Weeks or Months, which expanded Vapours will not do. And that it is elaſtic appears, by its dilating and contracting with Heat and Cold, as common Air does.

AIR then makes a very conſiderable Part of the Subſtance of Vegetables as well as Animals. And beſide theſe Particles of Air, which ſtrongly adhere to, and are wrought into their Subſtance, there is in them a large Quantity, which is upon the wing, and in a very active State.

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[h] MR. *Geoffroy* ſhews, that the mixture of any vitriolic Salts with inflammable Subſtances, will yield common *Brimſtone*: Particularly of *Oil of Vitriol* with *Oil of Turpentine*. Brimſtone therefore is nothing but vitriolic Salt, united with ſome combuſtible Subſtance.

Air is generated likewiſe from *Minerals* by Fermentation. By other fermenting Mixtures it is abſorbed again, and by others generated and abſorbed alternately.

A quarter of an inch of *filings of Iron*, and an inch of compound *Aquafortis*, in four days abſorbed 27 inches of Air. When hot water was poured upon it, it generated three or four inches, which after ſome days it abſorbed again. A quarter of an inch of *Iron-filings*, with an inch of powdered *Brimſtone*, abſorbed nineteen inches in two days. Powdered *Brimſtone* mixt with *Newcaſtle-Coal*, neither generated nor abſorbed.

An inch of *Chalk* and as much *Oil* of *Vitriol*, in three days generated 31 inches of Air. Part of this it afterward reſorbed. Two inches of *Lime* and as much *Sal Ammoniac* abſorbed 115 inches. The fumes of this are therefore very Suffocating. All burning and flaming Bodies, abſorb much Air. And whereas the Air which ſome Subſtances abſorb, is afterwards remitted, that which is abſorbed by burning Brimſtone, by the flame of a Candle, or by Human Reſpiration, does not recover its Elaſticity.

The Elaſticity of the Air in the Veſicles of the Lungs is continually decreaſing, thro' the Vapour it is there loaded with; ſo that there needs freſh Air continually; otherwiſe thoſe veſicles will ſoon fall flat, whereby the Motion of the Blood thro' the Lungs being ſtopt, inſtant Death enſues. And this ſeems to be exactly the caſe of moſt of thoſe, who are killed by Lightning, which ſo totally deſtroys the Elaſtic Air in the Lungs, that they inſtantly fall flat.

And that Candles ſoon go out, if they are confined in a ſmall Quantity of Air, ſeems not to be ſo much owing, to their having rendered the Air effete, by conſuming its vivifying Spirit, as to its deſtroying the Elaſticity thereof, by its acid, fuliginous Vapours.

But nothing deſtroys the Elaſticity of Air like Brimſtone, whether burning, or in fermenting Mixtures. And as the attractive Power of Bodies is found to be more or leſs, as they have more or fewer ſulphureous Particles, ſo we may reaſonably aſcribe the fixing the elaſtic Particles of Air, to the ſtrong Attraction of the ſulphureous Particles, with which Sir *Iſaac Newton* ſuppoſes all Bodies to abound, more or leſs.

THE various Mixtures in the Stomach ſometimes generate, ſometimes abſorb Air. In a good Digeſtion the generating Power exceeds the abſorbing Power but a little. When it exceeds it much, we may be troubled, more or leſs, with diſtending Flatus's.

WE have ſeen, how much Air may be extracted from Animal and Vegetable Bodies, into whoſe Subſtances it was before intimately and firmly incorporated. And conſequently, great Quantities of Air, muſt be continually expended in their Production. Part of this, we ſee, may reſume its elaſtic State, when their Texture is diſſolved. but Part probably never regains its Elaſticity, at leaſt not in many Centuries. However we may ſee, what immenſe Treaſures of this important Element, the wiſe Author of Nature has provided, the conſtant Waſte of it being abundantly ſupplied, by Heat or Fermentation from innumerable denſe Bodies.

IF all the Parts of Nature were endued with a ſtrongly attracting Power only, whole Nature would immediately become, one unactive, cohering Lump. It was therefore abſolutely neceſſary, there ſhould be every where intermixt, a due proportion of ſtrongly-elaſtic Particles. And ſince abundance of theſe are continually reduced from an elaſtic to a fixt State, it was alſo neceſſary, that theſe Particles ſhould be endued with a property of reſuming their Elaſticity, whenever they were diſengaged from that maſs in which they were fixt. And hereby this beautiful Frame of things, is maintained in a continual Round, of the production and diſſolution of Animal and Vegetable Bodies.

THE Air is very inſtrumental in the Production and Growth of Animals and Vegetables: In its elaſtic State, by invigorating their Juices; and in its fixt State, by greatly contributing, to the Union and firm Connection of their conſtituent Parts. It is alſo a very powerful Agent in the Diſſolution of the ſame Bodies.

Air acts upon other Bodies not only by its Elaſticity and Gravity, but by the peculiar Ingredients mixt with it. Thus 1. It diſſoves Bodies, not only by its Preſſure and Attrition, but as containing all ſorts of Menſtruums. Iron ſoon becomes ruſty in Air, unleſs defended by Oil. Pillars of Iron have been ſo reduced by Air, that one might crumble them to duſt between the fingers. And Copper is converted by it into a Subſtance like the Verdegreaſe produced by Vinegar. In our Southern Colonies great Guns ruſt ſo faſt in the Air, that in a few years large Cakes may be peeled off them. In *Peru* the Air diſſolves Lead: but it will not diſſolve Gold; becauſe Sea-ſalt being very difficult to volatilize, there is but little of it in the Atmoſphere. But in the Laboratories where Aqua Regia is preparing, the Air is much impregnated therewith. And Gold when expoſed to this Air, contracts Ruſt like other Metals. Air diſſolves Stone likewiſe. So the *Purbeck* Stone, of which *Saliſbury* Cathedral is built, is obſerved to become ſofter and ſofter, till it moulders away.

But pure Air is no where to be found. That which ſurrounds us is the moſt heterogeneous Body in nature. It is no other than an univerſal Chaos, a Colluvies of all kind of Bodies. No Bodies can withſtand the Force of Fire. And whatever Fire can volatilize is found in the Air. Hence for inſtance, the whole *Foſſil* Kingdom muſt be found therein: For all that tribe is convertible into Fume. Gold, the moſt fixt of all adheres to Sulphur in Mines, and is raiſed along with it. All the Parts of the *Animal* Kingdom muſt likewiſe be in the Air. For beſides the copious Effluvia they emit by Perſpiration (whereby an Animal in the courſe of its Duration, impregnates the Air with many times the quantity of its own Body) any dead Animal, when expoſed to the Air, is in a certain time carried wholly off. And we know that all *Vegetables* by Putrefaction become volatile, and ſo evaporate into Air.

Air, 2. volatilizes fixt Bodies. Thus Sea-ſalt being calcined and fuſed, then expoſed to the Air to liquefy; when liquefied, ſet to dry again; then fuſed again, and the Operation thus repeated; will by degrees be almoſt wholly evaporated, nothing remaining but a little Earth.

Air, 3 fixes volatile Bodies. Thus tho' Aqua-fortis or Spirit of Nitre, readily evaporates by the Fire; yet if the Air near be impregnated with Spirit of Urine, the volatile Spirit is fixt, and falls down in a liquid Form.

But the Air's being open or incloſed is of conſequence in Chymical Operations. So, to make Sulphur inflammable, a free Air is required: in a cloſe Veſſel it will not kindle. And thus all Animals and Vegetables can only be calcined in open Air. In cloſe Veſſels they never become any other than black Coals.

By the *Air-pump* the Air is in a great meaſure drawn out of a Veſſel called the *Receiver*. And hence we learn how much all vital, nutritive and alterative Powers depend upon the Air. A Candle in the exhauſted Receiver uſually goes out in a Minute. A kindled Charcoal is totally extinguiſhed in about five Minutes. Red-hot Iron is not affected thereby: Only it will not light Sulphur or Gunpowder, but melt it. Flint and Steel ſtrike fire there, and Load-ſtones act, as well as in the open Air. Smoke ſinks in a darkiſh Body to the bottom, leaving the upper Part clear and tranſparent. The Syphon does not run therein: But Attrition produces Heat, as in the open Air. If ſome Grains of an Heap of Gunpowder be kindled by a Burning-glaſs, they will not fire the contiguous Grains. Glow-worms loſe their Light, as the Air is exhauſted; but recover it, on its Re-admiſſion. Vipers and Frogs ſeem dead in leſs than two Hours, but recover in the open Air. Snails live ten Hours: Efts, two or three days; Leeches, five or ſix.

The *Atmoſphere* is a Body of Air and Vapours, which ſurrounds the Globe to the height of about Sixty Miles, gravitates toward its Centre, and is carried along with it in all its Motions. This continually preſſes on our Bodies, with a weight equal to a Pillar of Air, whoſe Baſe is equal to the Surface of our Bodies.

dies. Now a Pillar of Air of the height of the Atmoſphere, is equal to a Pillar of Water thirty-five feet high. Every foot ſquare therefore of the Surface of our Bodies is preſſed on by a weight of Air, equal to 35 cubic feet of Water: And a cubic foot of Water weighing 76 pound (*Troy* weight) conſequently every foot ſquare of the Surface of our Bodies, ſuſtains a Pillar of Air equal to 2260 Pounds. If then the Surface of a Man's Body contains fifteen ſquare feet, he ſuſtains a Weight equal to 39900 Pounds. This is the Caſe, when the Air is heavieſt. But the difference between the greateſt and the leaſt Preſſure of Air upon our Bodies is equal to 3982 Pounds.

HENCE it is ſo far from being a Wonder, we ſhould ſometimes ſuffer in our Health, by a Change of Weather, that it is the greateſt wonder, we ſhould not always ſuffer. For when we conſider, our Bodies are at ſome times preſt upon by near two ton weight more than at others, it is ſurprizing, that every Change, does not break our whole frame to pieces.

IN truth the Veſſels of our Bodies being ſo much ſtreightened by an increaſed Preſſure, would ſtagnate the Blood to the very Heart, had not the Author of Nature wiſely contrived, that when the Reſiſtence to its Circulation is greateſt, the force by which the Heart contracts ſhould be ſo too. For upon an increaſe of the Weight of the Air, the Lungs are more ſtrongly expanded, and the Blood by being more intimately broken, made fitter for the finer Secretions, the Nervous in particular, by which the Heart is more ſtrongly contracted. On the other hand, when the weight of the ambient Air is ever ſo little abated, the Air contained within the Blood, unfolds its Spring, and forces the Blood to take up a larger Space than it did before.

THE Reaſon we are not ſenſible of this Preſſure, is well explained by *Borelli*: Sand perfectly rammed into a hard Veſſel, can't be penetrated, even by a Wedge. And Water in a Bladder, compreſt on all ſides, can't give way in any part. In like manner, within the Skin of an Animal, are contained various Parts; ſome hard, as Bones; ſome ſoft, as Muſcles; and ſome fluid, as Blood. Now it is not poſſible that Bones, ſhould be broke or diſplaced in the Body, unleſs the preſſure lay heavier on one Part than on another. If the Preſſure be ſo divided, that it be equal all round, upward, downward, ſideways, and no part of the Skin be exempt therefrom, it is plain, no Fracture or Luxation can follow.

The ſame may be obſerved of the Muſcles and Nerves, which tho' ſoft, yet being compoſed of ſolid Fibres, do mutually ſuſtain each other, and reſiſt the common Weight. The ſame holds of the Blood and other Humours. As Water is not capable of Condenſation, ſo theſe Liquids, while contained in their Veſſels, cannot be forced out of them by an univerſal Compreſſion. Add to this, that the Air itſelf which is contained, in every Part of the Body, is ſuch a Ballance to the External Air, that no Hurt can enſue from its Preſſure.

CHAP. III.

Of Meteors.

1. *Of Vapours, Miſts and Clouds:*
2. *Of Dew and Rain:*
3. *Of Snow and Hail:*
4. *Of the Rainbow:*
5. *Of the Halo:*
6. *Of Mock Suns and Moons:*
7. *Of fiery Meteors, Thunder and Lightning:*
8. *Of Electricity:*
9. *Of Wind:*
10. *Reflections.*

1. WHATSOEVER is carried aloft into the Air, and ſuſpended there, is termed a *Meteor*. Theſe are either *Watry*, *Fiery*, or *Airy*. The Watry are *Miſts*, *Clouds*, *Rain*, *Snow*, *Hail*. Watry Particles which are rarefied ſo as to float in the Air, are then termed *Vapours*. If theſe are viſible and hang near the

Earth, we call them Miſts; if they are higher in the Air, *Clouds*. Some of theſe are ſo thin, as to tranſmit the Rays of the Sun, others ſo denſe, as to intercept them.

THE manner wherein the Vapours that conſtitute Clouds and Rain are raiſed ſeems to be this. Fire being the lighteſt of all Bodies, eaſily breaks looſe from them; and in its Paſſage carries along with it Particles or little Caſes of Water. Theſe being lighter than the Air, are buoyed up and ſwim therein: Till ſtriking againſt one another, or thickened by Cold, they are reduced into Clouds and Drops.

To illuſtrate this, we may obſerve in Water over the Fire, 1. That the Evaporations are proportioned to the Heat. A ſmall Heat throws off few Vapours, ſcarce viſible: A greater, carries off larger and more numerous Veſicles of Water, which we call a *Steam*. Violent Heat lifts up great Quantities of Water, which the Air cannot buoy up: and this we call *Boiling*. 2. If theſe Vapours be intercepted in their Aſcent, by any denſe Body, eſpecially if it be cold, they are thereby reduced into Drops, like thoſe of Rain. 3. In froſty Weather the Vapours riſe but a little above the Water, and there hang, or glide on. If the Weather be very cold; after a little Aſcent, they fall again into the Water. But in a warm, ſtill Air, they aſcend ſwiftly and largely, and mount up, 'till they are out of ſight.

2. THE *Dew* which uſually falls in *England* in a Year amounts to ſomething more than three Inches and a quarter depth. The Evaporation of a Winter's Day is nearly the ſame as that of a Summer's Day. For the Earth being moiſter in Winter, that exceſs of Moiſture anſwers to the Exceſs of Heat in Summer.

WITHIN the Tropics they have no Rain for many Months together But the Dews are far greater than with us. Yet the moiſture evaporated in a Summer's Day, far exceeds that which falls in the Night. Hence the Dews there, cannot be of any Benefit to the Roots of the Trees, becauſe they are remanded back from the Earth by the following Day's Heat, before they can ſoak to any conſiderable Depth. The great Benefit therefore of

Dew in hot weather muſt be, by being imbibed into Vegetables, to refreſh them for the preſent, and ſupply them with moiſture toward the expence of the ſucceeding Day.

MEANTIME the Sun draws freſh Supplies of Moiſture from the Strata of the Earth, which by means of his penetrating Warmth, inſinuates itſelf into the Roots. By the ſame genial Heat, it is carried up, thro' their Bodies and Branches, and thence paſſing into the Leaves it is vigorouſly acted upon in thoſe thin Plates, 'till perſpiring thro' their Surface, it mounts with rapidity in the free Air.

BUT the ſtrangeſt Circumſtance relating to Dew, is this. In the ſame Night, place ſeveral Subſtances in the open Air, while a large Dew falls; And ſome of them will receive much of it, ſome little, and others none at all. The Drops make a ſort of Choice, what Bodies they ſhall affix themſelves to. Glaſs and Cryſtals they fix themſelves to readily, and in the largeſt Quantity. Metals do not receive them at all, nor do the drops ever fix on them. If a Glaſs Veſſel be ſet out in an Evening, or a ſilver Plate, the Glaſs will be found quite covered with Dew, and the Silver perfectly dry. China-ware is a ſort of Glaſs. Six pounds of Mercury being expoſed to the Air in a China-Plate, the Dew ran in Streams on the edge of the Plate, but not a drop was on the Mercury.

IS there not ſome Alliance between the Phænomena obſerved in Dew, and thoſe which appear in electric Bodies? All hard Bodies may by rubbing become Electric, excepting only Metals And Metals are the only Bodies, which wholly refuſe to admit the Dew. But the Cauſes of one or the other Phænomenon, who is able to explain?

IF Clouds are condenſed, ſo as to fall in Drops, this we ſtile *Rain*. It may riſe from various Cauſes. Sometimes Cold alone condenſes a warm Cloud. But it is generally Wind, which preſſes the Cloud ſo cloſe together, that the Particles of Water united in large Drops, which being ſpecifically heavier than the Air, can no longer be ſuſpended by it.

Bloody Rains, as they have been ſometimes called, ſeem to be only the Excrements of Inſects. Accordingly *Gaſſendus* gives us an Account of a bloody Rain in *France*, which much terrified the People. But upon Enquiry, it was found to be only red drops, coming from a ſort of Butterflies which flew about in great numbers.

DURING a Scarcity in *Sileſia*, a Rumour was ſpread, of its *raining Millet-Seed*. But it was ſoon found to be only the ſeeds of the ſmall *Hen-bit*, growing thereabouts in great Plenty. So in the *Archipelago* it was thought *Aſhes* were rained, with which Ships were covered for many Leagues. But in truth, they came from Eruption of *Veſuvius*, happening at that time. More lately it was reported at *Warminſter* in *Wiltſhire*, that it rained *Wheat*. But the ſuppoſed Wheat was really Ivy-berries, blown thither in a conſiderable Quantity by a Hurrican. Nay, in 1696 a Field near *Cranſtead* in *Kent*, was overſpread with young Whitings, ſuppoſed to fall from the Clouds, but doubtleſs brought thither from the Sea, by a violent Storm.

NOR is it ſtrange that any of theſe things, ſhould be thus tranſported by tempeſtuous Winds, conſidering to what Diſtance, and in what Quantities the Sea-water was carried by the Storm, *Nov.* 26, 1703. A Phyſician travelling ſoon after, twenty miles from the Sea, chewing ſome tops of Hedges, found them ſalt. The Graſs of the Down about *Lewes* was ſo ſalt, that for ſome time the Sheep could not eat it. And the Miller three miles from the Sea, attempting with his Man to ſecure his Mill, were ſo waſhed with Flaſhes of Sea-water, that they were almoſt Strangled.

3. WHEN the Particles of Water in a Cloud are frozen, it occaſions *Snow*, which floats in the Air 'till it is driven together, ſo as to be heavy enough to ſink. When the drops of Rain in falling toward the Earth, meet with a Stream of cold Air, they are often froze into Ice, and ſo fall to the ground in the form of *Hail*. Hence the reaſon appears, why Snow, which is only frozen Miſt, is lighter than either Rain or Hail.

EVEN in our temperate Climate, we have ſometimes had very extraordinary Showers of Hail. On April 29, 1697, a thick black Cloud coming from *Carnarvonſhire*, poured ſuch an Hail on *Cheſhire*, *Lancaſhire* and ſome other Counties, that in a line two miles broad and ſixty miles long, it did inconceivable Damage. It not only killed all ſmall Animals, but ſplit Trees, and beat down Horſes and Men. The Hail-ſtones many of which weighed five Ounces, ſome ſeven or eight, and were of various Figures: Some round, others half round, ſome ſmooth, others emboſſed, or variouſly granulated. The icy Subſtance of them was tranſparent and hard; but there was a ſnowy Kernel in the middle of each.

MAY 4, in the ſame Year, there was a Shower of Hail in *Hertfordſhire*, which exceeded this. Fields of Rye were cut down as with a Scythe; ſeveral Men killed, and vaſt Oaks ſplit. The Stones were from ten to fourteen Inches round, ſome oval, ſome pecked and others flat.

Mezeray relates, that in *Italy*, in 1510, there was, after an horrible Darkneſs, a Shower of Hail, which deſtroyed all the Fiſh, Birds and Beaſts of that Country. It was attended with a ſtrong Smell of Sulphur. Some of the Stones weighed an hundred pounds.

MANY Particles of Snow are of a regular Figure, like Rowels, or Stars of ſix points. On each of theſe points, are other collateral Stars, but many of the Points are broken. Others having been thawed are froze again into irregular Cluſters. All theſe are perfect Ice, ſo that the whole of Snow is an infinite number of Icicles. A Cloud of Vapours condenſing forthwith deſcends, 'til meeting with a freezing Air, each Drop immediately becomes an Icicle, ſhooting itſelf into ſeveral Points. Theſe deſcending ſtill, and either ſtriking on each other, or meeting with Gales of warmer Air, are a little blunted or thawed, and froze again into Cluſters, and ſo intangled as to fall in flakes. But even then the largeneſs of its Surface, compared to the Matter contained, makes it extremely light.

4. THE *Rainbow* is always ſeen in the Region oppoſite to the Sun, and never but when it rains on that Side. Its Colours are conſtantly in this Order, the outermoſt Red, the next yellow, the third Green, the innermoſt Violet

Colour: But theſe are not always equally vivid. When two Rainbows appear, the Upper exhibits the ſame Colours, but fainter, and in an inverted Order. The Seat of the Rainbow is the drops of Rain, on which the Rays of the Sun fall, and after various Refractions and Reflections, ſtrike on the Eye of the Beholder. This is rendered indiſputable from hence, that the very Colours, and in the ſame Order, are exhibited in the Drops of Water, ſpouted from a Fountain.

THE *Moon* alſo ſometimes exhibits a Rainbow; but only when ſhe is full: Her Light being at other times too faint to affect the Sight after two Refractions and a Reflection. It has all the Colours of the Solar Rainbow, very diſtinct and pleaſant, only conſiderably fainter.

A RAINBOW is likewiſe ſometimes exhibited by *the Sea*, when a ſtrong Wind carries the tops of the Waves aloft, and the Sun's Rays falling upon them are refracted and reflected, as in a Shower. But the Colours of this are leſs lively, leſs diſtinct, and leſs durable than thoſe of the Common Bow. Scarce above two Colours are diſtinguiſhable, a dark yellow, on the ſide next the Sun, and a pale Green on the oppoſite Side. But ſometimes 20 or 30 of them are ſeen at once. They appear at Noon Day, in a Poſition oppoſite to that of the common Rainbow, the concave Side being turned upwards.

5. *Halo's* are Circles of various Colours, which are ſometimes ſeen round the Sun or Moon. The Space contained within them (eſpecially near thoſe Parts which are tinctured with the moſt lively Colours) is more duſky than the Sky without. (They never appear in rainy Weather.) Perhaps the Air is at that time full of very ſmall, icy Particles, on which the Rays of the Sun or Moon falling, after Refraction, exhibit that Appearance.

6. As to *Mock Suns*, we ſometimes ſee a large, white Circle, parallel to the Horizon, in ſeveral Parts, whereof more or fewer Suns appear, tho' not always of the ſame Size or Colour. As an Halo frequently appears at the ſame time, it is probable they ſpring from much the ſame Cauſe, namely from icy Particles floating in the Air, between the Sun and the Eye of the Spectator. The Rays of the Sun reflected from theſe, may form that

bright Circle, in certain Parts whereof, by a double Refraction and Reflexion of them, thoſe fictitious Suns appear. In the ſame manner, the Appearances termed *Mock Moons* may be accounted for.

7. Among *Fiery Meteors* are reckoned, *Thunder*, *Lightning*, *Ignes Fatui*, *Lambent-Flames*, and what are called *Falling Stars*. Unleſs we account for theſe (as indeed it is eaſy to do) upon the Principles of Electricity, we muſt ſuppoſe they are owing to ſulphureous or bituminous Particles, floating in the Air, which when collected in ſufficient Quantities, take fire by various Means. If a large Quantity of inflammable Vapour, takes fire at once, the Flame tears the Cloud with incredible force, as well as immenſe Noiſe. But the Light moving ſwifter than the Sound, is ſeen before that is heard. Sometimes an Exhalation of a milder kind takes fire, and produces Lightning without Thunder. When it thunders and lightens, it commonly rains too, the ſame Shock driving together and condenſing the Clouds. And the Wiſdom of God appoints it ſo, for the Preſervation of his Creatures. For if Lightning falls on one who is throughly wet, it does him no harm at all. Not that the Water quenches or reſiſts the Fire; but it conveys it into the Ground.

High Places are moſt frequently ſtruck with Lightning, if they have ſharp Points, as Spires of Churches, or Tops of Trees, which as it were attract the Fire. It ſometimes burns the Cloaths without hurting the Body; ſometimes breaks the Bones without ſcorching the Skin. It melts the Sword in the Scabbard or Money in the Pocket, while the Scabbard or Pocket remains as it was. In general, it paſſes innocently thro' thoſe things that make little or no reſiſtence; but tears thoſe in pieces with impetuous force, which reſiſt its Paſſage.

One very peculiar Effect of Lightning, is what the Vulgar call *Fairy Circles*. Theſe are of two kinds. One kind, is a round, bare Path, about a foot broad, with green Graſs in the middle, and is frequently ſeven or eight yards in Diameter. The other is a

Circle of the ſame Breadth, of very green Graſs, much freſher than that in the middle. Theſe are generally obſerved after Storms of Thunder and Lightning. And it is no wonder, that Lightning, like other Fires, moves circularly, and burns more at the Extremity than in the middle. The Second kind of Circles without all doubt ſpring originally from the Firſt: The Graſs which was burnt up by the Lightning, growing afterward more freſh and green.

VAPOURS of the ſame kind that give riſe to Lightnings in the Air, occaſion *Damps* in the Earth. The Damps in Mines are of four Sorts. The Approach of the Firſt and moſt common is known by the Flame of the Candle leſſening 'till it goes out: As alſo by the Men's Difficulty of breathing. Thoſe who eſcape Swooning are not much hurt by this: but thoſe who ſwoon away, are commonly on their recovery, ſeized with ſtrong Convulſions. The Second is the *Peas-bloom Damp*, ſo called becauſe of its Smell. This comes only in Summer, and is common in the *Peak* of *Derbyſhire*. But it is never mortal. They who have ſeen the Third ſort of Damp, deſcribe it thus. In the higheſt Part of the Roof of thoſe Paſſages in a Mine, which branch out from the main Grove, a round thing hangs, about as big as a Foot-ball, covered with a thin Skin. If this be broken, the Damp immediately ſpreads and ſuffocates all that are near. But ſometimes they contrive to break it at a diſtance, after which they purify the place with Fire. The Fourth is the *Fire-damp:* A Vapour which if touched by the Flame of a Candle, takes fire and goes off like Gunpowder. And yet ſome who have had all their Cloaths burnt off by one of theſe, and their Fleſh torne off their Bones, at the very time felt no Heat at all, but as it were a cool Air.

SIR *James Lowther* having collected ſome of this Air in Bladders, brought it up to *London*. Being let out at the Orifice thro' a tobacco-pipe, it would take fire at the Flame of a Candle. And even this is imitable by Art. Moſt Metals emit ſulphureous Vapours, while they are diſſolving in their ſeveral Menſtruums.

Iron, for inſtance, while it diſſolves in Oil of Vitriol, emits much ſulphureous Vapour. If this be received into a Bladder, and afterward let out in a ſmall Stream, it takes fire, juſt in the ſame manner as the natural Vapour.

THIS Experiment explains one Cauſe of Earthquakes and Volcano's, ſince it appears hence, that nothing more is neceſſary to form them, than Iron mixing with Vitriolic Acid and Water. Now Iron is generally found accompanied with Sulphur, and Sulphur conſiſts of an inflammable Oil, and an Acid like oil of Vitriol.

THIS Acid in the Bowels of the Earth, being diluted with a little Water, becomes a Menſtruum to Iron, with violent Effervеſcence and an intenſe Heat. The Air coming from this Mixture is extremely rarefied, and the more it is compreſſed by the incumbent Earth, ſo much the more its impetus will be increaſed, to an unlimited Degree. Nor does there need Fire to ſet theſe Vapours to work. The Air in the Bladder, if it be much heated, will of itſelf take fire, as ſoon as it is brought into contact with the external Air. [i]

ANOTHER

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[i] OTHER Damps are ſometimes as mortal as thoſe in Mines. In the year 1701, a Maſon being at work in the City of *Rennes*, near the brink of a Well, let his Hammer fall into it. A Labourer who was ſent down for it, was ſuffocated, before he reached the Water. A Second, ſent to draw him up, met with the ſame Fate. So did a Third. At laſt a Fourth, half drunk, was let down, with a charge to call out immediately, if he felt any Inconvenience. He did call, as ſoon as he came near the water, and was drawn up inſtantly. Yet he died in three Days, crying out, he felt a Heat, which ſcorched his Entrails. Yet the three Carcaſes being drawn up with Hooks and opened, there appeared no Cauſe of their Death.

THE ſame Hiſtorians relate, that a Baker of *Chartes*, having carried ſeven or eight Buſhels of Brands out of his Oven into a Cellar 36 Stairs deep, his Son, a ſtrong young Fellow, going with more, his Candle went out on the middle of the Stairs. Having lighted it afreſh, he no ſooner got into the Cellar, than he cried for Help, and they heard no more of him. His Brother, an able Youth, ran down, cried, " I am dead," and was heard no more. He was followed by his Wife, and ſhe by a Maid, and ſtill it was the ſame. Yet an hardy Fellow reſolved to go and help them: He cried too, Another Appearance which reſembles Lightning is the *Aurora Borealis*, commonly called *Northern Lights*. This is uſually of a reddiſh Colour, inclining to yellow, and ſends out Coruſcations of bright Light, which ſeem to riſe from the Horizon in a Pyramidal Form, and ſhoot with great Velocity up to the Zenith. It appears frequently in the form of an Arch, riſes far above the Region of the Clouds; yet never appears near the Equator, but always nearer the Poles.

Ignis fatuus, vulgarly called *Will with the Wiſp*, is chiefly ſeen in dark Nights, irregularly moving over Meadows, Marſhes, and other moiſt Places. It ſeems to be a viſcous Exhalation, which being kindled in the Air, reflects a kind of thin Flame in the dark, tho' without any ſenſible Heat. It is often found to fly along Rivers or Hedges, probably becauſe it there meets with a Stream of Air to direct it. In *Italy* there are luminous Appearances, nearly reſembling theſe, which on a cloſe Inſpection have been found to be no other than Swarms of ſhining Flies.

One of the moſt ſingular kinds of *lambent Fires*, is that diſcovered at certain times on Sea-water. Where the Ship goes ſwiftly in the Night, in many Seas the whole breaking of the water will appear behind it, as if on Fire, ſparkling and ſhining all the way that it moves from the Ship.

It is in this part as bright and glittering, as if the Moon ſhone upon it, and chiefly when there is neither Moon nor Stars, nor any Light in the Lanterns. But it is not always the ſame; ſometimes it is ſcarce perceivable, ſometimes very vivid and bright. Sometimes it is only

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and was ſeen no more. A Sixth Man deſired an hook to draw ſome of them out. He drew up the Maid, who fetched a Sigh and died. Next day one undertook to draw up the reſt, and was let down on a woodden Horſe with ropes, to be drawn up whenever he ſhould call. He ſoon called, but the Rope breaking, he fell back again, and was a while after drawn up dead. Upon opening him the Membranes of the Brain were found extremely ſtretched, his Lungs ſpotted with Blood, his Inteſtines ſwelled as big as one's Arm and red as Blood, and all the Muſcles of his Arms, Thighs and Legs, torne and ſeparated from their Bones.

only juſt behind the Ship; ſometimes it ſpreads a great way on each ſide. It commonly reaches 30 or 40 feet from the Stern of the Ship, but is fainter as it is farther off. At the Stern it is often ſo bright, that a perſon on deck may ſee to read by it. The luminous Water that follows the Ship, is ſometimes diſtinct from the reſt of the Surface. Sometimes it is ſo blended with the adjacent Water, that the Appearance is confuſed. The luminous Matter ſeems compoſed of ſmall Sparkles, which are ſometimes in the Figure of a Star, ſometimes it forms Globules, without any Radiations from them. Theſe are, ſome of the Size of a large pin's Head; ſome larger even to a foot in diameter. Sometimes the Luminous Matter is in oblong Squares, of three or four Inches. When the Ship goes ſwiftly theſe Figures all combine and form a ſort of luminous Whirlpool. Nor does a Ship only, but whatever moves ſwift thro' the Sea, cauſe the ſame Appearance. Large Fiſh when they ſwim near the Surface leave a luminous Road behind them. So do a number of Fiſh moving together. And ſometimes the throwing out a Rope, or any thing that breaks the Surface of the Water, will render it luminous. If Sea-water be taken up, and placed in a Veſſel, as ſoon as it is ſtirred, it will ſparkle: And if a linen Rag be dipt in Sea-water, and hung up, when it is throughly dried, it will appear luminous on being rubbed in the dark: And when half dry, it need only be ſhook, to ſhew a great number of Sparkles. When theſe Sparkles are once formed and fall on any ſolid Body, they will laſt a conſiderable time. If they remain on the Water, they will ſoon go out.

The Waves beating againſt the Rocks or Shore, yea or againſt one another, will occaſion the ſame Appearance and often yield a long Courſe of Light the whole Night. In the *Brazils* the Shores often ſeem all on fire, by the Waves daſhing againſt them. In general, the thicker and fouler the Seas are, the more of this Light they afford. In many places the Sea is covered with a yellowiſh Matter, like Saw-duſt, which ſeems to be the Excrement of ſome Sea-Animal. The Water where this is found, gives more Light upon moving than any other.

Some Parts of the Northern Seas are covered with this, for ſeveral Leagues together, and this is often luminous all over in the night, tho' not ſtirred by any thing moving thro' it.

In the Gulph of *Venice* the Water is luminous, only from the beginning of Summer 'till the End of Harveſt. This Light is moſt copious in places abounding with Sea-graſs, eſpecially when any thing moves the Water. One filled a flaſk with this Water; but it emitted no Light, 'till it was ſtirred in the dark. When this was ſtrained thro' a fine Cloth, the Cloth ſhone in the dark, but not the Water. This Light conſiſted of innumerable lucid Particles. When ſome of this Sea-graſs was taken up, there were above thirty of theſe Particles on one Leaf, one of which when it was ſhaken, fell off. It was as fine as an Eye-laſh and about as long. Viewed with a Microſcope it appeared to be a Worm or Maggot, conſiſting of Eleven Rings, with as many Mamillæ on the ſides inſtead of Feet. Their whole Bodies were lucid, tho' leaſt ſo, when at reſt In Spring they confine themſelves to the Sea-graſs: but in Summer they are diſperſed all over the Sea, and moſtly on the Surface. When this Sea ſparkles more than uſual, it is the ſure ſign of a Storm: And this proceeds from the greater Agitation of the Worms, already ſenſible of the approaching Change. Hence it is clear, that the glittering of this Sea, in a Ship's Courſe, is occaſioned by theſe Worms: Which probably is the Caſe in ſome other Seas alſo. And they are certainly the Cauſe of the Light in the *Pinna-Marina*, a large Muſcle, frequently caught by the *Algerine* Fiſhermen. Many *Sea-fiſh* indeed have a viſcous matter about their Gills, eſpecially when they have been ſome time dead. Theſe when kept in Sea-water ſhine as bright as a flaming Coal. A Stick rubbed on their Gills, becomes luminous wherever it has touched them, and continues ſo, while it continues moiſt; but as it dries, the Light fades.

There is a ſmall Shell-fiſh, called a *Dactylus*, which is luminous all over. When it is taken out of the Shell in the dark, every Part of its Surface ſhines with a bright Light. Nor is it the Surface only; but the whole Body. For if it be wounded either lengthways or acroſs, the cut Parts are as luminous as the Surface. It is therefore a true, natural Phoſphorus, and makes every thing luminous that touches it, which remains ſo as long as it is wet. When it is freſh caught, it abounds with water, and the very drops which fall from it, are luminous.

The Light of a *Glow-worm* is ſo ſtrong, that it will ſhew itſelf thro' ſeveral Subſtances. The Creature ſeems dead in the day-time, and its Light is not then viſible, even in a dark Room, unleſs it be put in motion, and then it is very faint. After Sun-ſet the Light begins to return, and with it the Life and Motion of the Animal. Indeed the Motion and Light ſeem to depend on each other: It never ſhines, but when it moves: And when it ſhines moſt, the Body is one third longer than in the Day-time. While it ſhines brighteſt, it ſometimes turns about, and the Light is no larger than a pin's head. But on being touched, it immediately extends itſelf, and the Light is as large and bright as ever.

The luminous Parts are two ſmall Specks under the Tail. The uſe of this Light is, to direct the Animal in its Courſe, and in taking of its Prey. It is admirably placed for this purpoſe. The Tail is eaſily bent under its Belly, and throws its Light full upon any Object, about or under the Head of the Animal, and the Eyes are placed not on the upper Part, but on the under ſide of the Head, ſo that they have all the Advantages of it, while the Light in this Part is not offenſive to the Eyes, as it naturally would have been, if carried about the Head. The Creature can upon occaſion cover this Light, ſo as not to be known, or purſued by its Enemies. It is an Inſect of the Beetle-kind, of a brown and duſky Colour. It has Shell-Wings as the other Beetles have. Its Head is covered with a ſort of broad-brimmed Hat, under which are the Eyes which are black and large.

Falling Stars, ſo called, ſeem to be a Vapour of an unctuous kind, kindled in the lower Regions of the Air: Unleſs this alſo (as many other Phænomena of the ſort) be owing to what is vulgarly termed *Electricity*.

8. From a thouſand Experiments it appears, that there is a fluid far more ſubtle than Air, which is every where diffuſed thro' all Space, which ſurrounds the Earth and pervades every Part of it. And ſuch is the extreme Fineneſs, Velocity and Expanſiveneſs of this active Principle, that all other Matter ſeems to be only the Body, and this the Soul of the Univerſe.

It is highly probable this is the general Inſtrument of all the Motion in the Univerſe: From this *pure Fire,* (which is properly ſo called) the vulgar *Culinary* Fire is kindled. For in Truth there is but one Kind of Fire in Nature, which exiſts in all Places and in all Bodies. And this is ſubtle and active enough, not only to be, under the Great Cauſe, the ſecondary Cauſe of Motion, but to produce and ſuſtain Life throughout all Nature, as well in Animals as in Vegetables.

This great Machine of the World requires ſome ſuch conſtant, active and powerful Principle, conſtituted by its Creator, to keep the heavenly Bodies in their ſeveral Courſes, and at the ſame Time give Support, Life and Increaſe to the various Inhabitants of the Earth. Now as the Heart of every Animal is the Engine which circulates the Blood thro' the whole Body, ſo the Sun, as the Heat of the World, circulates this Fire thro' the whole Univerſe. And this Element is not capable of any eſſential Alteration, Increaſe or Diminution. It is a Species by itſelf; and is of a Nature totally diſtinct from that of all other Bodies.

That this is abſolutely neceſſary both to feed common Fire, and to ſuſtain the Life of Animals, it ſeems may be learned from an eaſy Experiment. Place a Cat, together with a lighted Candle, in a cold Oven: Then lute the Door cloſe, having fixt a Glaſs in the Middle of it: And if you look thro' this, you may obſerve, at one and the ſame Inſtant, the Candle goes out, and the Animal dies. A plain Proof, that the ſame Fire is needful to ſuſtain both culinary Fire and animal Life: And a large Quantity of it. Some doubtleſs pervades the Oven Door; but not enough to ſuſtain either Flame or Life. Indeed every Animal is a kind of Fire-Engine. As ſoon as the Lungs inſpire the Air, the Fire mingled with it is inſtantly diſperſed thro' the pulmonary Veſſels into the Blood: Thence it is diffuſed thro' every Part of the Body, even the moſt minute Arteries, Veins and Nerves. In the mean Time the Lungs inſpire more Air and Fire, and ſo provide a conſtant Supply.

THE Air ſeems to be univerſally impregnated with this Fire, but ſo diluted, as not to hurt the Animal in Reſpiration. So a ſmall Quantity of a Liquor dropt in Water, may be friendly to an human Body, tho' a few Drops of the ſame Liquor, given by themſelves, would have occaſioned certain Death. And yet you cannot conceive one Particle of the Water, without a Particle of the Medicine. 'Tis not impoſſible, this may be one great Uſe of Air, by adhering ſo cloſely to the elementary Fire, to temper and render ſalutary to the Body, what would otherwiſe be fatal to it.

To put it beyond diſpute, that this Fire is largely mixt with the Air, you may make the following Experiment. Take a round Lump of Iron, and heat it to a degree called a *welding* Heat: Take it out of the Fire, and with a Pair of Bellows blow cold Air upon it. The Iron will then as effectually melt, as if it were in the hotteſt Fire. Now when taken out of the Forge, it had not Fire enough in it to conquer the Coheſion of its Parts: But when this Fire is joined with that which was mixt with the Air, it is ſufficient to do it. On the ſame Principle we account for the Increaſe of a Coal or Wood Fire by blowing it.

AND let none wonder that Fire ſhould be ſo connected with Air, as hardly to be ſeparated. As ſubtle as Fire is, we may even by Art attach it to other Bodies; yea, and keep it Priſoner for many Years: And that either in a ſolid or fluid Form. An Inſtance of the firſt we have in Steel: Which is made ſuch, only by impacting a large Quantity of Fire into Bars of Iron. In like Manner we impact a great Quantity of Fire into Stone, to make Lime. An Inſtance of the ſecond Kind we have in Spirits, wherein Fire is impriſon'd in a fluid a fluid Form. Hence common Spirits will burn all away. And if you throw into the Air Spirits rectified to the higheſt Degree, not one Drop will come down again, but the univerſal Fire will take hold of and abſorb it all.

That this Fire ſubſiſts both in Air, Earth, and Water; that it is diffuſed thro' all and every Part of the Univerſe, was *ſuſpected* by many of the antient Naturaliſts, and *believed* by the great Sir *Iſaac Newton.* But of late Years it has been fully demonſtrated: Particularly, by Mr. *Stephen Gray*, a Penſioner at the *Charterhouſe*; who ſome Years ſince preſented to the Royal Society, an Account of many Experiments he had made, whereby this ſubtle Fluid became clearly perceptible both to the Sight and Feeling. Becauſe the Glaſs Tube, by Means of which thoſe Experiments were made, was obſerved when rubbed to attract Straws and other light Bodies (a known Property of Amber, called in *Latin Electrum) theſe* Experiments were termed *electrical:* A Word which was ſoon affixt to that ſubtle Fluid itſelf, and every Thing pertaining to it. But improperly enough: Seeing the attracting (or ſeeming to attract) Straws and Feathers, is one of the moſt inconſiderable of all the Effects, wrought by this powerful and univerſal Cauſe.

It was afterwards found, that a Glaſs Globe was preferable to a Glaſs Tube A greater Quantity of ethereal Fire is *collected* by this Means than by the other. I ſay *collected*; for that Fire is no more *created* by rubbing, than Water is by pumping. The grand Reſervoir thereof is the Earth, from which it is diffuſed every way. Accordingly in theſe Experiments the Globe rubbing againſt the Cuſhion, collects Fire from it. The Cuſhion receives it from the Frame of the Machine; the Frame of the Machine from the Floor. But if you cut off the Communication with the Floor, no Fire can be *produced,* becauſe none can be *collected.*

Many new Diſcoveries have been made by Means of a large but thin Glaſs Phial. This Phial is hung on any metallic Body, which communicates by a Wire, with the Globe. This metallic Body has been termed, *the prime Conductor*, as it conducts or conveys the Fire collected by the Globe, either into the Phial, or into any other Body communicating therewith.

But all Bodies are not capable of receiving it. There is in this Reſpect an amazing Difference between them. The Excrements of Nature, as Wax, Silk, Hair, will not receive the ethereal Fire, neither convey it to other Bodies: So that whenever in circulating it comes to any of theſe, it is at a full ſtop. Air itſelf is a Body of this Kind; with great Difficulty either receiving or conveying this Fire to other Bodies: So are Pitch and Roſin (Excrements, as it were, of Trees.) To theſe we may add Glaſs, Amber, Brimſtone, dry Earth, and a few other Bodies. Theſe have been frequently ſtiled *Electrics per ſe*; as if they alone contained the *electric Fire*: An eminently improper Title, founded on a palpable Miſtake. From the ſame Miſtake, all other Bodies, which eaſily receive and readily convey it, were termed *Non electrics*; on a Suppoſition, that they contained no *electric Fire*: The contrary of which is now allowed by all.

That this Fire is inconceivably ſubtle, appears from its permeating even the denſeſt Metals, and that with ſuch Eaſe, as to receive no perceptible Reſiſtance. If any one doubt, whether it paſs thro' the Subſtance, or only along the Surface of Bodies, a ſtrong Shock taken thro' his own Body, will prevent his doubting any longer. It differs from all other Matter in this, that the Particles of it repel, not attract, each other. And hence is the manifeſt Divergency in a Stream of electrical Effluvia. But tho' the Particles of it repel each other, yet are they attracted by all other Matter. And from theſe three, the extreme ſubtlety of this Fire, the mutual Repulſion of its Parts, and the ſtrong Attraction of them by other Matter, ariſes this Effect, that if a Quantity of electric Fire be applied to a Maſs of common Matter of any Bigneſs or Length, (which has not already got its Quantity) it is immediately diffuſed thro' the whole.

It ſeems, this Globe of Earth and Water, with its Plants, Animals, Buildings, have diffuſed thro' their whole Subſtance, juſt as much of this Fire as they will contain. And this we may term their *natural Quantity*. This is not the ſame in all Kinds of Matter: Neither in the ſame Kind of Matter, in all Circumſtances. A ſolid Foot of one Kind of Matter (as Glaſs) contains more of it than a ſolid Foot of another Kind. And a Pound Weight of the ſame Kind of Matter, when rarefied, contains more than it did before.

We know that this Fire is *in* common Matter, becauſe we can pump it *out*, by the Globe: We know that common Matter has near as much of it as it can contain, becauſe if we add a little more to any Portion of it, the additional Quantity does not enter, but forms a Kind of Atmoſphere round it. On the other Hand, we know that common Matter has not more of it than it can contain. Otherwiſe all looſe Portions of it would repel each other; as they conſtantly do, when they have ſuch Atmoſpheres. Had the Earth, for Inſtance, as much electric Fire in Propottion, as we can give to a Globe of Iron or Wood, the Particles of Duſt and other light Matter, would not only repel each other, but be continually repelled from the Earth. Hence the Air being conſtantly loaded therewith, would be unfit for Reſpiration. Here we ſee another Occaſion to adore that Wiſdom, which has made all Things by Weight and Meaſure.

The Form of every electric Atmoſphere, is that of the Body which it ſurrounds: Becauſe it is attracted by every Part of the Surface, tho' it cannot enter the Subſtance already replete Without this Attraction, it would not remain round the Body, but diſſipate into the Air.

The Atmoſphere of an electrified Sphere, is not more eaſily drawn off, from any one Part of it than from the other, becauſe it is equally attracted by every Part. But it is not ſo with Bodies of other Figures. From a Cube it is more eaſily drawn off at the Corners than at the Sides: And ſo from the Corners of Bodies of any other Form, and moſt eaſily from the ſharpeſt

Corners. For the Force with which an electrified Body retains its Atmoſphere, is proportioned to the Surface on which that Atmoſphere reſts. So a Surface four Inches ſquare retains its Atmoſphere, with ſixteen Times the Force that one of an Inch ſquare does. And as in pulling the Hairs from an Horſe's Tail, a Force inſufficient to pull off an Handful at once, could eaſily pull it off Hair by Hair: So tho' a blunt Body can't draw off all the Atmoſphere at once, a pointed one can eaſily draw it off, Particle by Particle.

WHILE the electric Fire, which is in all Bodies, is left to itſelf, undiſturb'd by any external Violence, it is more or leſs denſe, according to the Nature of the Body which it is in. In denſe Bodies it is more rare: In rare Bodies it is more denſe. Accordingly every Body contains ſuch a Quantity of it, rare or denſe, as is ſuitable to its Nature. And there is ſome Reſiſtance to every Endeavour of altering its Denſity, in the whole of any Body, or in any Part of it. For all Bodies reſiſt either the Increaſe or Diminution of their natural Quantity. And on the other Hand, when it has been either increaſed or diminiſhed, there is a Reſiſtance to its Return to its natural State.

WITH regard to the different Reſiſtance made by different Bodies, in either of theſe Caſes, it is an invariable Rule, that Glaſs, Wax, Roſin, Brimſtone, Silk, Hair, and ſuch like Bodies, reſiſt the moſt: And next to theſe, the Air, provided it be dry, and in a ſufficient Quantity. That this Reſiſtance is leaſt in Metals, Minerals, Water, Quickſilver, Animals and Vegetables: Which we may rank together, becauſe the Difference in their Reſiſtance is very inconſiderable: And that in theſe Bodies the Reſiſtance is greater, when their Surfaces are poliſh'd, and extended in length, than when their Surfaces are rough and ſhort, or end in ſharp Points.

WHEN a Body has more electric Fire forced into it, than it has naturally, it is ſaid to be electrified *poſitively*. When Part of the natural Quantity is taken away, it is ſaid to be electrified *negatively*. Now when an Iron Bar is *negatively* electrified, the Fire drawn out, does not go in again as ſoon as the Experiment is over, but forms an Atmoſphere round it, becauſe of the Reſiſtance it finds in its Endeavour to dilate itſelf, either into the Air or into the Bar. And when it is electrified *poſitively*, the ſame Kind of Atmoſphere is form'd, by the Fire accumulated upon it. Whether therefore Bodies are electrified negatively or poſitively, and remain ſo when the Experiment is over, there are ſimilar Atmoſpheres ſurrounding them, which will produce ſimilar Effects.

But we can electrify no Body beyond a certain Degree: Becauſe when any is electrified to that Point, it has an Atmoſphere round it ſufficiently ſtrong to ballance any Power that endeavours to electrify it farther.

And in the ordinary Courſe of Nature, this ſubtle, active Fluid, which not only ſurrounds every groſs Body, but every component Particle of each, where it is not in abſolute Contact with its neighbouring Particle can never be idle, but is ever in Action, tho that Action be imperceptible to our Senſes. It is ever varying its Condition, tho' imperceptibly, in all Parts of all Bodies whatever; and electrifying them more or leſs, tho' not ſo forcibly as to give ſenſible Signs of it. All Bodies then, and all their component Particles, when in their natural Situation, have round their Surfaces, where they are not in abſolute Contact with other Surfaces, an imperceptible Atmoſphere ſufficient to ballance the ſmaller Force with which they are attacked: Every Way ſimilar to the perceptible Atmoſphere of Bodies forcibly electrified. In theſe imperceptible Atmoſpheres is placed the Power which reſiſts their being electrified to an higher Degree than they are naturally. And this Power lies in the Elaſticity of the ſubtle Fluid, every where diſperſed both round all Bodies and in them.

Glass is very difficultly electrified, which ſeems to prove it has a very denſe electric Atmoſphere. Metals are eaſily electrified. Conſequently they have rare and therefore weakly reſiſting Atmoſpheres. But as Heat rarefies all Bodies, ſo if Glaſs be heated to a certain Degree, even below melting, it will give as free a Paſſage to the electric Fire, as Braſs or Iron does: The Atmoſphere round it being then rendered as rare as that of Metals. Nay, when melted, it makes no more Reſiſtance than Water. But its Reſiſtance increaſes, as it cools. And when it is quite cold, it reſiſts as forcibly as ever. Smoothly-poliſhed Wax reſiſts as much as Glaſs. But even the ſmall Heat raiſed by rubbing, will render its Atmoſphere as rare as that of Metals, and ſo intirely deſtroy its Reſiſtance. The ſame is true of Roſin and Brimſtone. Even the Heat ariſing from Friction, deſtroys the Reſiſtance which they naturally make to being electrified: A ſtrong Proof, that the Reſiſtance of all Bodies thereto, is exerted at their Surfaces, and cauſed by an electric Atmoſphere of different Denſities, according to the different Circumſtances.

Most Experiments will ſucceed as well with a Globe of Brimſtone, as with one of Glaſs. Yet there is a conſiderable Difference in their Nature. What Glaſs repels, Brimſtone (as alſo Roſin) attracts. Rubbed Glaſs emits the electric Fire: Rubbed Brimſtone, Roſin and Wax receive it. Hence if a Glaſs Globe be turned at one end of a prime Conductor, and a Brimſtone one at the other, not a Spark of Fire can be obtained; one receiving it in, as faſt as it is given out by the other. Hence alſo if a Phial be ſuſpended on the prime Conductor, with a Chain from its Coating to the Table, and only one Globe turned, it will be electrified (or *charged*, as they term it) by twenty turns of the Wheel: After which it may be *diſcharged*, that is, unelectrified, by twenty Turns of the other Wheel.

The Difference between *Non Electrics* (vulgarly ſpeaking) and *Electrics per ſe*, is chiefly this. 1. A *Non Electric* eaſily ſuffers a Change, in the Quantity of Fire it contains. Its whole Quantity may be leſſen'd by drawing out a Part, which it will afterwards reſume. But you can only leſſen the Quantity contain'd in one of the Surfaces of an *Electric*: And not that, but by adding at the ſame Time an equal Quantity to the other Surface. So that the whole Glaſs will always have the ſame Quantity in its two Surfaces. And even this can only be done in Glaſs that is thin: Beyond a certain Thickneſs we know no Power that can make this Change. 2. The ethereal Fire freely moves from Place to Place, in and thro' the Subſtance of a *Non Electric*. But thro' the Subſtance of an *Electric* it will by no Means paſs. It freely enters an Iron-Rod, and moves from one end to another, where the Overplus is diſcharged. But it will not enter, or move thro' a Glaſs-Rod. Neither will the thineſt Glaſs which can be made, ſuffer any Particle of it entering one of its Surfaces, to paſs thro' to the other.

INDEED it is only Metals and Liquids, that perfectly *conduct* (or tranſmit) this Fire. Other Bodies ſeem to conduct it, only ſo far as they contain a Mixture of theſe; accordingly moiſt Air will conduct it in Proportion to its Moiſtneſs. But dry Air will not conduct it at all: On the contrary, it is the main Inſtrument, in confining any electric Atmoſphere, to the Body which it ſurrounds. Dry Air prevents its diſſipating (which it does preſently when *in vacuo)* or paſſing from Body to Body. A clear Bottle full of Air, inſtead of Water, cannot be electrified. But exhauſted of Air, it is electrified as effectually as if it was full of Water. Yet an Electrical Atmoſphere and Air, do not exclude one another. For we breathe in it freely, and dry Air will blow thro' it, without altering it at all.

WHEN a Glaſs Phial is electrified, whatever Quantity of Fire is accumulated on the inner Surface, an equal Quantity is taken from the outer. Suppoſe, before the Operation begins, the Quantity of Fire contain'd in each Surface, is equal to twenty Grains: Suppoſe at every Turn of the Globe, one Grain is thrown in: Then after the firſt Stroke there are twenty-one within, nineteen only without: After the ſecond, the inner Surface will have twenty-two, the outer but eighteen: And ſo on, till after twenty Strokes, the inner will have forty, the outer none. And the Operation ends: For no Power or Art of Man can throw any more on the inner Surface, when no more can be taken from the outer. If you attempt to throw more in, it is thrown back thro' the Wire, or flies out in Cracks thro' the Sides of the Phial. The Equilibrium cannot be reſtored in this Phial, but by a Communication form'd between the inner and outer Surface, by ſomething external, touching both the outer, and the Wire which communicates with the inner Surface. If you touch theſe by turns, it is reſtored by Degrees: If both at once, it is reſtored inſtantly. But then there is a Shock occaſioned by the ſudden paſſing of the Fire thro' the Body, in its Way from the inner to the outer Surface. For it moves from the Wire to the Finger, (not from the Finger to the Wire, as is commonly ſuppoſed). Thence it paſſes thro' the Body to the other Hand, and ſo to the outer Surface.

The Force with which this Shock may be given, is far greater than one would conceive. It will kill Rats, Hens, or even Turkeys in a Moment: Others, that are not quite killed, it ſtrikes blind. It will give Polarity to a fine Needle, making it point North and South, as if touched by a Loadſtone. It will invert the Polarity of a Compaſs, and make the North Point turn to the South. At the ſame Time the Ends of the Needles are finely blued like the Spring of a Watch. It will melt off the Heads and Points of Pins and Needles: And ſometimes the whole Surface of the Needle is run and appears as it were bliſtered, when examined by a magnifying Glaſs. It will melt thin Gold or Silver, when held tight between two Panes of Glaſs, together with the Surface of the Glaſs itſelf, and incorporate them in a fine Enamel. Yea a ſtrong Spark from an electrified Phial, makes a fair Hole thro' a Quire of Paper doubled: Which is thought good Armour againſt the Puſh of a Sword, or even a Piſtol Bullet. And 'tis amazing to obſerve in how ſmall a Portion of Glaſs, a great Electrical Force may be. A thin Glaſs Bubble, about an Inch Diameter, being half filled with Water, partly gilt on the outſide, when electrified gives as ſtrong a Shock as a Man can well bear: Allowing then that it contains no more Fire after charging than before, how much Fire muſt there be in this ſmall Glaſs! It ſeems to be a Part of its very Subſtance. Perhaps if that Fire could be ſeparated from it, it would be no longer Glaſs. It might in loſing this loſe its moſt eſſential Properties, its Tranſparency, Brittleneſs, and Elaſticity.

SOME have not improbably ſuppoſed, that all *Electric* Bodies, ſo called, are by their original Conſtitution, thro'ly ſaturated with Electric Fire: That it remains fixt in them, (unleſs while the Texture of thoſe Bodies is quite alter'd by Liquefaction) that Fire fixt in a Body conſtitutes an *Electric*, and all Bodies where it is not fixt are *Non Electrics*. Agreeably to which they ſuppoſe, that in all *Non Electrics*, the Original Fire, looſely inhering, is eaſily driven on by the new collected Fire, which then poſſeſſes its Place: But that in *Electrics* the Original Fire being impacted into their Subſtance, and therefore more firmly inhering, will not give Way to, or be driven on by, the new collected Fire. Such is Air in particular; with the Particles of which the original Fire is cloſely incorporated. Dry Air ſeems to be ſo fully ſaturated with it, that it is ſcarce capable of receiving any more: Whereas all new-collected Fire is continually endeavouring to return into the Earth. Let Wires be electrified ever ſo ſtrongly, yet the Moment any Part of them is touch'd by a Perſon ſtanding on the Floor, they are electrified no longer; all the Fire eſcaping thro' him into the Earth.

UPON the Principles of Electricity, w emay give a more rational Account, of many Appearances in Nature, than has yet been done: Of Thunder and Lightning in particular. In order to which we may obſerve, all electrified Bodies retain the Fire thrown into them, till ſome Non-electric approaches: To which it is then communicated with a Snap, and becomes equally divided. Electric Fire is ſtrongly attracted by Water, and readily mixes with it. And Water being electrified, the Vapours ariſing from it, are equally electrified. As theſe float in the Air, they retain the additional Fire, till they meet with Clouds not ſo much electrified. Then they communicate it with a Shock.

THE Ocean is compounded of Water, and Salt; one an Electric, the other not. When there is a Friction among the Parts near its Surface, the Fire is collected from the Parts below. It is then plainly viſible in the Night, at the Stern of every ſailing Veſſel. It appears from every Daſh of an Oar: In Storms the whole Sea ſeems on Fire. The Particles of Water then repell'd from the electrified Surface, continually carry off the Fire as it is collected. They riſe and form Clouds which are highly electrified, and retain the Fire till they have an Opportunity of diſcharging it.

PARTICLES of Water riſing in Vapours, attach themſelves to Particles of Air. One Particle of Air may be ſurrounded by twelve Particles of Water as large as itſelf, all touching it, and by more added to them. Particles of Air thus loaded would be drawn nearer together by the mutual Attraction of the Particles of Water, did not the Fire, Common or Electric, included therein, aſſiſt their mutual Repulſion. Hence they continue ſuſpended. But if Air thus loaded, be compreſs'd by adverſe Winds, or by being driven againſt Mountains, or if it be condenſed by the Loſs of its Fire, it will continue ſuſpended no longer, but will deſcend in Dew. And if the Water ſurrounding one Particle of Air comes into contact with that ſurrounding another, they naturally coaleſce into a Drop, and ſo deſcend in Rain.

THE Sun ſupplies common Fire to all Vapours, riſing either from Sea or Land. Vapours having both this and Electric Fire, are better ſupported than thoſe which have this only. For when Vapours riſe into the coldeſt Region, the common Fire may fail. But the Cold will not diminiſh the Electric: This is always the ſame. Hence Clouds raiſed from freſh Waters, from moiſt Earth or growing Vegetables, more eaſily deſcend and depoſite their Waters, as having but little Electric Fire, to keep the Particles ſeparate from each other. So that the greateſt Part of the Water raiſed from the Land, falls on the Land again. But Clouds raiſed from the Sea, having both Fire, and much of the Electric, ſupport their Water far more ſtrongly, and being aſſiſted by Winds, may bring it from the Middle of the wideſt Ocean to the Middle of the broadeſt Continent. And yet a Way is provided whereby theſe alſo are readily brought to depoſite their Water. For whenever they are driven againſt Mountains by the Winds, thoſe Mountains take away their Electric Fire: And being cold, the common alſo: Hence the Particles immediately cloſe. If the Air was not much loaded, the Water falls in Dew on the Top and the

Sides of the Mountain. If it was, the Electric Fire being taken at once from the whole Cloud, it flaſhes brightly, and cracks loudly. And the Particles inſtantly coaleſcing for want of that Fire, fall in an heavy Shower.

When a Ridge of Mountains ſtops the Clouds, and draws the Electric Fire from the Cloud firſt approaching it, the next when it comes near the firſt, now deprived of its Fire, flaſhes into it, and depoſites its own Water. The third Cloud approaching, and all that ſucceed, act in the ſame Manner; as far back as they extend, which may be for ſeveral hundred Miles. Hence the continual Storms of Thunder, Lightning and Rain, on the Eaſt Side of thoſe vaſt Mountains, the *Andes*, which running North and South, intercept all the Clouds brought againſt them from the *Atlantick* Ocean. In a plain Country, there are other Means to make them drop their Water. For if an electrified Cloud coming from the Sea, meets in the Air a Cloud coming from the Land, and therefore not electrified, the firſt will give its Flaſh into the latter, and thereby both will be made to depoſite their Water. The Concuſſion of the Air contributes alſo to ſhake down the Water, not only from thoſe two Clouds, but from others near them. When the Sea and Land Clouds would paſs at too great a Diſtance from each other, they are mutually attracted 'till within the Diſtance. For the Sphere of Electrical Attraction is far beyond the flaſhing Diſtance. And yet where a Cloud contains much Fire, it may ſtrike at a conſiderable Diſtance. When a Conductor has but little Fire in it, you muſt approach very near before you can draw a Spark. Throw into it a greater Quantity of Fire, and it will give a Spark at a greater Diſtance. But if a Gun Barrel, when electrified, will ſtrike and make a Noiſe, at the Diſtance of an Inch, at what a Diſtance, and with how great a Noiſe, may ten thouſand Acres of electrified Cloud ſtrike? No Wonder that this ſhould melt Metals (which our artificial Flaſh does in ſome Degree) tho' perhaps not ſo properly by its Heat, as by inſinuating into the Pores, and creating a violent Repulſion between the Particles of the Metal it paſſes thro'. This overcomes the Attraction whereby they cohere, and ſo melts the metallic Body. And this accounts for its melting a Sword in the Scabbard, or Gold in the Pocket, without burning either.

BUT Thunder-Clouds do not always contain more than their natural Quantity of Electric Fire. Very frequently they contain leſs. And when this is the Caſe, when they are negatively electrified, altho' the Effects and Appearances are nearly the ſame, yet the Manner of Operation is different. For in this Caſe, it is really the Fire from the Mountains, or other Part of the Earth which ſtrikes into the Cloud; and not, as we imagine, Fire from the Cloud which ſtrikes into the Earth. And we may eaſily conceive, how a Cloud may be negatively electrified. When a Portion of Water is rarefied into a thin Vapour, the Fire it contains is rarefied too. Conſequently it has then leſs than its natural Quantity of Fire. Such a Cloud therefore coming within a due Diſtance of the Earth, will receive from it a Flaſh of Electric Fire; which Flaſh, to ſupply a great Extent of Cloud, muſt often contain a great Quantity of Fire. Such a Cloud alſo paſſing over Woods of tall Trees, may ſilently receive ſome Supply, either from the Points of the Boughs, or from the ſharp Ends and Edges of the Leaves. The Cloud thus ſupplied, flaſhes into other Clouds that have not been ſo ſupplied; and thoſe into others, 'till an Equilibrium is produced, among all that are within a ſtriking Diſtance of each other. And hence are repeated Strokes and Flaſhes, 'till they deſcend in Showers to the Earth, their Original. Rain, eſpecially when in large Drops, generally brings down the Electric Fire: Falling Snow often: Summer Hail, always, tho' ſilently. Conſequently any of theſe may prevent Thunder and Lightning; or at leaſt, abate its Violence. Rain is helpful in another Reſpect likewiſe. By wetting Men or Beaſts, it ſaves many Lives. For if your Cloaths are throughly wet, and a Flaſh of Lightning ſtrikes the Top of your Head, it will run in the Water over the Surface of your Body into the Ground: Whereas if your Cloaths were not wet, it would go thro' your Body. Hence a wet Chicken cannot be killed by a Stroke from the Phial; whereas a dry one is killed in an Inſtant. See here alſo the Wiſdom and Goodneſs of Him, *who ſendeth forth Lightning with the Rain!* It ſhould likewiſe be obſerved, that wherever electrified Clouds paſs, Spires, Towers, Chimneys, and high Trees, as ſo many Points, draw the Electric Fire, and the whole Cloud frequently diſcharges there. Therefore it is highly dangerous in ſuch a Storm, to take Shelter under a Tree.

COMMON Fire is more or leſs in all Bodies, as well as Electrical. If there be a ſufficient Quantity of either in any Body, it is inflamed. But when the Quantity of common Fire therein is ſmall, there needs more Electric Fire to inflame it. Where the Quantity of common Fire is greater, leſs of the Electric will ſuffice. So if Spirits are heated, a ſmall Spark inflames them. If they are not, the Spark muſt be greater. Sulphureous Vapours, whether riſing from the Earth, or from Stacks of moiſt Hay or Corn, or any other heated and reeking Vegetable, contain abundance of common Fire. A ſmall Addition of Electric then will inflame them. Therefore they are eaſily kindled by Lightning.

ANY who would be clearly convinced of the Nature of Lightning, may make the following Experiment. Make a ſmall Croſs of two thin Stripes of Wood, the Arms being juſt ſo long, as to reach the four Corners of a large, thin Silk Handkerchief when extended. Tie the Corners of this to the Extremities of the Croſs; and ſo you have the Body of a Kite: Add to this a proper Tail, Loop and String, and it will riſe in the Air like one made with Paper: But this is fitter to bear the Wind and Wet in a Storm without tearing. To the Top of the Croſs fix a ſharp pointed Wire, riſing a Foot above it. Tie a Silk Ribbon to the End of the Twine next the Hand; and where the Silk and Twine join, faſten a Key. Raiſe this Kite when a Thunder-Storm is coming on: But he that holds the String, muſt ſtand in a Porch, or under ſome other Covering, that the Ribbon may not be wet. He muſt likewiſe take particular Care, that the

Twine do not touch the Top or Side of the Porch. As ſoon as the Thunder-Cloud comes over the Kite, the pointed Wire draws the Electric Fire from it. The Kite and all the Twine are then electrified, as plainly appears by this, that the looſe Filaments of the Twine ſtand out every way, and are attracted by an approaching Finger. And when the Kite and Twine being wet, conduct the Fire freely, it will ſtream from the Key, on the Approach of the Knuckle. By this Key the Phial may be charged, and all other Experiments made, as by the Globe. And this is a Demonſtration, that the Electric Fire thereby obtained, is the very ſame with that of Lightning.

SCARCE any Phænomenon in Nature has been eſteemed more difficult to be accounted for than thoſe luminous Appearances in the Sky, termed *Aurora, Borealis*, or *Nothern Lights*. But theſe alſo may be rationally explained, upon the Principles of Electricity. We often ſee Clouds at different Heights, paſſing different Ways, North and South at the ſame Time. This manifeſtly proves different Currents of Air, one of them under the other. Now as the Air between the Tropics is rarefied by the Sun, it riſes; the denſer Air preſſing into its Place. The Air ſo raiſed, moves North and South, and if it has no Opportunity before, muſt deſcend in the Polar Regions. When this Air with its Vapours deſcends into contact with the Vapours ariſing there, the Electric Fire which it brought begins to be communicated, and is ſeen in clear Nights; being firſt viſible where it is firſt in Motion, namely in the moſt Northern Parts. But from thence the Streams of Light ſeem to ſhoot Southerly, even to the Zenith of Northern Countries.

To the ſame principle we may refer what ſome term St. *Helmo's fire*, and the Antients *Caſtor* and *Pollux*, a thin. ſhining Light, which is ſometimes ſeen dancing on the Decks or Rigging of Ships. A very remarkable Account of this, is given by a late Author. "In the night it became exceeding dark and thundered and lightened dreadfully. We ſaw meantime on different Parts of the Ship, above thirty St. *Helmo's fires*. One, which was on the top of the Vane of the Mainmaſt, was more than a foot and a half in length. I ordered one of the Sailors to take down the Vane: The Noiſe of the fire reſembled that of fired, wet Gunpowder. Scarce had he lowered the Vane, but the Fire left it, and fixt on the top of the Mainmaſt. After remaining there a conſiderable time, it went out by little and little.

" How immenſe a Quantity of electric Matter muſt have been at that time in the Atmoſphere ſurrounding the Ship, to furniſh more than thirty St. *Helmo's Fires*, (the ſame we ſee at the end of our Conductors in electrifying) One of which was above a foot and an half long? The Maſt, Yards and every Part of the Ship were then real Conductors of the electric Fire between the Atmoſphere and the Sea, and by that means preſerved the Ship."

A PERSON electrified acquires a Flammific Power, ſtrong enough to light with one of his Fingers, or with his Cane, warm Brandy. When the finger draws near, a crackling Spark iſſues out and ſets it on fire.

THE Electric Sparkles of Iron are of a ſilver white, thoſe of Braſs, Green, thoſe drawn from an Egg, yellowiſh. This ſeems to prove, that the Electric Matter iſſuing from a Body, is ſaturated with ſome Parts peculiar to it.

ELECTRICITY quickens almoſt all ſorts of Motion, that of Water in particular, which then glitters in the dark, the Fire appearing intermingled with the Water. It accelerates the Motion of the Human Blood, quickening the Pulſe fifteen or ſixteen Strokes in a Minute. The Blood that flows from the vein of one electrified, gliſters, ſeparates into ſmall Drops, and ſpouts out conſiderably farther than otherwiſe it would do.

IT exceedingly haſtens the Vegetation of Plants. Myrtle-trees which were electrified, budded much ſooner than others of the ſame kind and bigneſs, in the ſame Green-houſe. And Seeds electrified daily have ſhot up and grown more in three or four Days, than others of the ſame kind, and alike in all other Circumſtances, have done in Eleven or Twelve.

It cures abundance of Diſeaſes, even the moſt ſtubborn; particularly thoſe of the Nervous Kind: Many of them, in a moment, by a ſingle Touch; Moſt, in a few Days. So that this is not only one of the greateſt Curioſities in the World, but one of the nobleſt Medicines that God ever gave to Man.

Another Phænomenon, which could never before be accounted for, is undoubtedly owing to this Cauſe, the *Sparkling* obſerved on *New Flannel*, when it is rubbed in the dark. Very probably the acid Steams of the Sulphur, which is burnt under the Flannel when it is bleached, unite with the Oil wherewith Hair always abounds, and ſo form an animal Sulphur, which upon any ſtrong Agitation of theſe Hairs, will become luminous. This Sparkling is moſt obſervable in froſty Weather, as Electricity is always ſtrongeſt at that time. Flannel loſes this Property when it is waſhed, the lixivial Salts of the Soap, deſtroying the ſulphureous Acid, and likewiſe dicharging its native Acid. The wearing Flannel, even without its being waſhed, will have the ſame effect: As the Effluvia which go off in Perſpiration, diſſolve the Sulphur, and weaken the Spring of the Hair.

9. ***Wind*** is a Current of Air. Wherever the Air is rarefied or condenſed beyond its natural Degree, a Wind muſt neceſſarily enſue, 'till the Equilibrium be reſtored: the condenſed Air immediately expanding itſelf, toward that which was rarefied. The Cauſes of this Condenſation or Rarefaction, are Heat, Cold and a thouſand things beſide.

A Wind of a very peculiar kind, paſſed over the City of *Rome*, on the Night of the 11th of June 1749. There firſt appeared a very black, long and lofty Cloud, which emitted Flames on all ſides. It moved along with a ſurprizing ſwiftneſs, within three or four feet of the ground. It firſt gathered in the neighbouring Sea, came from *Oſtia* to *Rome*, entered the City between the Gates of St. *Paul* and St. *Sebaſtian*, and croſſing in a ſtrait line, went out at the North Angle of a large Square, between the *Porta pia* and that of St. *Lawrence*. It ſtript off the Roofs of Houſes, blew down the Chimneys, broke doors and windows, forced up the Floors, and unpaved the Rooms. It tore up the Vines and overthrew the Trees in its way, and where its Action was moſt violent, the very rafters of Houſes were broke, yea and hurled againſt Houſes at a conſiderable diſtance. The loftieſt Buildings felt its fury the moſt: thoſe of one Story were little damaged. It was traced to ſome diſtance without the City: then it died away.

THE Motion of all theſe Hurricans is circular, and they carry up into the Air, Tiles, Stones, and whatever comes in their way, and throw them violently to a conſiderable Diſtance. To this may be owing ſome of thoſe ſurprizing Showers, which are recorded in Hiſtory. A Whirlwind, for inſtance, paſſes over a place where Wool is ſpread to dry. It takes it up, and ſcatters it in ſmall Locks, at a conſiderable Diſtance. Here is the Appearance of a ſhower of Wool. If it ſweeps along a mineral Rivulet, of which there are many among the Mountains of *Italy*, it carries innumerable metallic particles away, and ſprinkles them on ſome diſtant Town or Fields. Here is what they call a Shower of Iron.

ONE Species of Hurricans is that which is termed a *Water-ſpout*. Theſe are ſeen to deſcend from a Cloud as a Pillar, having two Motions, one round their own Axis, the other progreſſive in a ſtrait Direction. Such a Spout is a Gyration of Clouds, by contrary Winds meeting in the Centre, and there (where the Condenſation and Gravitation are greateſt) ſinking down into a great Tube, like a Screw. In its working and whirling, it ſucks and raiſes the Water, in the ſame manner as the Spiral Screw does. One of theſe ſometimes appears on the Land. On June 21. ſome years ſince, the Clouds near *Hatfield* in *Yorkſhire* were obſerved to be much agitated and driven together. They ſoon became very black, and were hurried round: Hence proceeded a whirling Noiſe like that of a Mill. Soon after there iſſued a long Tube, from the Centre of the congregated Clouds, having a Screw-like Motion, by which Means the Water wherever it came was raiſed up. In Auguſt following, the Wind blowing at the ſame time out of ſeveral Quarters, created a great Whirling among the Clouds, the Centre of which every now and then ſunk down, like a long, black Pipe, wherein was diſtinctly ſeen a Motion like that of a Screw, continually drawing and ſcrewing up, as it were, whatever it touched. Groves and Trees bent under it circularly, like Wands. Some of the Branches it tore off. It is commonly ſuppoſed, that the Water at Sea riſes in a Column, before the Tube touches it. But this is a Miſtake. The Tube touches the Surface of the Sea, before the Water riſes at all.

10. It remains only to add a few Reflections, on ſome of the preceding Heads.

How uſeful is the Atmoſphere to the Life, the Health, the Comfort, and the Buſineſs of the whole Globe! It is the Air, [k] by which all Animals live: Not only the Inhabitants of the Earth, but of the Waters too. Without it moſt Animals live ſcarce half a minute; and none of them, many Days.

And not only Animals, but even Trees and Plants owe their Life and Vegetation to this uſeful Element: As is manifeſt from their Glory and Verdure in a free

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[k] As the Air is of abſolute Neceſſity to Animal Life, ſo it is neceſſary it ſhould be of a due Conſiſtence, not foul, for that ſuffocates, not too thin; for that ſuffices not.

In the Diving-bell, after ſome time of ſtay under water, they are forced to come up and take in freſh Air. But *Cornelius Drebell* contrived not only a Veſſel to be rowed under water, but alſo a Liquor to be carried therein, that would ſupply the Want of freſh Air. The Veſſel was made for *King James* the Firſt. It carried Twelve Rowers, beſide the Paſſengers. It was tried in the *Thames.* A Perſon who was therein told it one who related it to Mr. *Boyle.* As to the Liquor, Mr. *Boyle* diſcovered by a Phyſician who married *Drebell's* Daughter, that from time to time, when the Air in the ſubmarine Boat was ſo clogged by the Breath of the Company, as to be unfit for Reſpiration, by unſtopping a Veſſel full of this, he ſpeedily reſtored it, ſo that they breathed again without difficulty.

And as too groſs, ſo too thin an Air, is unfit for Reſpiration. Hence the Difficulty of breathing (as all Travellers relate) upon the top of high Mountains. But the Cauſe of this Difficulty is not the Thinneſs only, but the too great Lightneſs thereof, which renders it unable to be a counterballance to the Heat, and all the Muſcles miniſtring to Reſpiration.

Air, and their Paleneſs and Sicklineſs, when excluded from it.

Thus neceſſary is the Air to the Life of Animals. And it is no leſs ſo, to the Conveyance of many of them. All the winged Tribes owe their Flight and Buoyancy to it. And even the Inhabitants of the Waters, cannot eaſily aſcend or deſcend in their own Element without it.

It would be endleſs to ſpecify the Uſes of the Air in the Operations of Nature. To touch only on one or two Inſtances. How admirable is that Property of it, the conſerving animated Bodies, whether Animal or Vegetable, while it diſſolves all other Bodies; by which means many things which would prove Nuſances to the World, are put out of the way and reduced to their firſt Principles. Even Chryſtal-Glaſſes, eſpecially if not uſed, it will in time reduce to powder. And thus divers Minerals, Stones, Foſſil-ſhells, Trees, which have lain under ground for many Ages, and ſo ſecure from Corruption, when in the open Air, have quickly mouldered away.

Another admirable Uſe of our Atmoſphere is, its miniſtring to the enlightning the Earth, by reflecting to us the Light of the Sun, [l] and refracting his Beams to our Eye, before he ſurmounts our Horizon, by which means the Day is protracted throughout the whole Globe, and the long and diſmal Nights are ſhortned in the frigid Zones. Yea, the Sun riſes in appearance, when he is indeed many degrees below the Horizon. [m]

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[l] To this is owing that Whiteneſs which is in the Air in the Day-time, cauſed by the Rays of Light ſtriking on the Particles of the Atmoſphere, as well as upon the Clouds above, and the other Objects beneath on the Earth. To the ſame Cauſe we owe the Twilight, namely to the Sun-beams touching the uppermoſt Parts of the Atmoſphere, which they do, when the Sun is eighteen Degrees below the Horizon.

[m] Let us a little more attentively conſider, the Light which whitens the Sky before the Sun riſes. There is ſomething ſurprizing in this. We ſee the Light only by the Rays which flow to our Eyes. Now the Sun being as yet beneath the Earth, cannot project any of his Rays directly to us. And the Rays which dart on the Extremities of the Land that terminates our ſight, proceed farther into the Heavens, unleſs they meet with any Body, which reflects them back to us. Is there any particular Body in nature deſigned to do us this

BUT barely mentioning theſe things, I ſhall only inſiſt on the excellent Uſe of the Atmoſphere, in reſpect of Two of its Meteors, the Winds, and the Clouds and Rain.

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Service? There is, namely the Atmoſphere, which is framed over our heads in ſuch a manner, that notwithſtanding its extenſive Maſs, it ſuffers us to ſee the Stars, at an immenſe diſtance from us; and notwithſtanding its Tranſparency, bends and gathers for us numberleſs Rays, of which we ſhould otherwiſe be quite deprived.

ANY Ray that falls perpendicularly on the Atmoſphere, enters it without any obſtacle, and deſcends thro' it to the Earth in the ſame right Line. But thoſe which fall obliquely upon it, are admitted into, or repelled from it, according to the Situation of the luminous Body. If this be more than eighteen degrees below the Horizon, all its Rays are ſcattered abroad. If leſs, the Rays enter the Atmoſphere and are refracted to our ſight. This is the true Cauſe of the Twilight, and indeed of the Continuance and principal Beauty of the Day, even when the Sun is in its higheſt Elevation. The Earth which receives his Rays reflects them into the Atmoſphere, which once more returns the greater Part of them. Thus it preſerves to us that Splendor, which is the Beauty of Nature, and that Heat which is the Soul of it. For it collects numberleſs Rays, the greater or ſmaller Union whereof, is the meaſure of Heat and Cold. Thus it becomes to us a Mantle of the fineſt texture, redoubling the Heat, yet not preſſing us by its Weight.

THE Atmoſphere at the ſame time cauſes and maintains round us, that Light which lays our whole Habitation before our Eyes. In order to clear this, ſuppoſe the Atmoſphere were deſtroyed, 1. The riſing of the Sun would not be preceded by any Twilight, but the moſt intenſe Darkneſs would ſurround us, 'till the moment of his Riſing. 2. In that inſtant he would break out in his full Brightneſs, and ſo continue 'till his Setting: And that moment it would be pitch dark. 3. In the day his Light would reſemble a clear Fire, which we ſee by night in the midſt of a ſpacious Field. We ſhould ſee what was near us, but nothing elſe: The diſtant Lands would not be perceived, and the Night would ſtill continue, notwithſtanding the Sun. For inſtead of the white Tint of Day, which diſplays all Nature by brightning the Azure of the Heavens, and colouring all the Horizon, we ſhould ſee nothing but an Abyſs of Darkneſs, there being nothing to reflect the ſolar Rays. The Stars indeed would be ſeen at Noon-day: But then thoſe luminous Bodies, which now appear to be placed in a delightful Azure, would ſeem faſtened on a diſmal, mourning Carpet.

“ BUT how does that fine Azure depend on the Atmoſphere?” This will plainly appear, if it be conſidered, what a Quantity of rarefied Water is ſuſpended, from the top of the Atmoſphere to the bottom. And there is never a greater Quantity ſuſpended there, than

The [a] Winds are of ſuch abſolute Neceſſity to the Wholſomeneſs of the Atmoſphere, that all the World would be poiſoned without thoſe Agitations. We find how putrid and unfit for Reſpiration, a confined, ſtagnating Air is. And if the whole Maſs of Air and Vapours were always at reſt, inſtead of refreſhing, it would ſuffocate all the world. But the Motion it receives from the Gales and Storms, keeps it pure, and healthy ſtill.

Without theſe Gales to fan us alſo, in the Heat of Summer, even in our temperate Climate, Men would hardly be able to go thro' their daily Labour, without indangering their Health. [o] Theſe are perpetual in

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in the fine Days, when no Clouds are to be ſeen. It is theſe rarefied Waters, that intercept and reflect to us, the Rays reflected from the Earth. And this prodigious Maſs of Waters, being a ſimple and uniform Body, the Colour of it is ſimple and always the ſame.

“ But are theſe azure Skies, which we confound with the ſtarry Heaven, nothing more than a little Air and Water? And what we took for the Heaven, only a Cover wrapt cloſe round the Earth?” So it is. And this is a new Wonder, and a new Proof of our Creator's Wiſdom! A few ſmall Bubbles of Air and Water are indeed in themſelves things very inſignificant; but that Hand which has with ſo much Art and Caution placed them over our Heads, has done it merely, that his Sun and Stars might not be rendered uſeleſs to us. He embelliſhes whatever He pleaſes; and theſe drops of Water and Air become in his Hands an inexhauſtible Source of Glory. He draws from them thoſe Twilights, which ſo uſefully prepare our Eyes for the receiving a ſtronger Light. He fetches out of them the Brightneſs of the Dawn. From them He produces the Splendor of the Day. He makes them contribute to the Increaſe and Preſervation of that Heat which nouriſhes every thing breathing. Of them He makes a brilliant Arch, which inchants the Sight of Man and becomes the Ceiling of his Habitation.

[a] The moſt univerſal and conſtant Alterations of the Balance of the Atmoſphere are from Heat and Cold. This is manifeſt in the general Trade-Winds, blowing all the Year between the Tropics from Eaſt to Weſt: The Cauſe whereof is undoubtedly by the Sun's daily Progreſs round that Part of the Globe, by his Heat rarefying one Part of the Air, while the cooler and heavier Air behind preſſes after.

In Thunder-Storms there are often two Currents of Air, the Under-Current contrary to the Upper. Hence the Wind near the Earth blows one way, and the Clouds above move the other way.

[o] *July* 8, 1707, called for ſome time after, *The hot Tueſday*, was ſo exceſſively hot and ſuffocating, by reaſon of there being no Wind

the Torrid Zone, and make what the antients imagined, to be not habitable to any but wild Beaſts, an healthful and pleaſant Habitation.

Of what uſe likewiſe are the Winds, to tranſport men to the diſtant Regions of the World? Particularly, the General and Coaſting Trade-Winds, the Sea [p] and the Land-Breezes; the One ſerving to carry the Mariner in long Voyages from Eaſt to Weſt, the other, to waft him to particular Places: The One ſerving to carry him into his Harbour, the other to bring him out.

The Clouds and Rain are no leſs uſeful Meteors than the Winds, as is manifeſt in the refreſhing Shade which the Clouds afford, and the fertile Dews and Showers, which they pour down on the Trees and Plants, which would languiſh and die with perpetual Drought, but are hereby made verdant and flouriſhing; ſo that as the Pſalmiſt ſaith, *The little hills rejoice on every ſide, and the valleys ſhout for joy and ſing.*

A farther Improvement of theſe Remarks I ſubjoin in the Words of Mr. *Hervey*.

" If we turn our Thoughts to the *Atmoſphere*, we find a moſt curious and exquiſite Apparatus of *Air*. This is a Source of innumerable Advantages; all which are fetched from the very Jaws of Ruin. To explain this. The *Preſſure* of the Air on a Perſon of a moderate Size is

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at all, that divers Perſons died in their Harveſt-Work. An healthy, luſty, young man near *Upminſter* in particular, was killed on the Spot by the Heat: And ſeveral Travellers on the Road, dropt down and died.

[p] Sea-breezes commonly riſe in the Morning, about Nine o'clock. They firſt approach the Shore gently, as if they were afraid to come near it. The Breeze comes in a fine, ſmall, black Curl upon the Water, whereas all the Sea between it and the Shore, is as ſmooth and even as Glaſs. In half an hour after it reaches the Shore, it fans pretty briſkly, and ſo increaſes gradually 'till twelve o'clock: Then it is commonly the ſtrongeſt. It laſts ſo 'till two or three. At three it begins to die away, 'till about five it is lulled aſleep.

As the Sea-breezes blow in the Day and reſt in the Night, the Land-breezes blow in the Night and reſt in the Day. They ſpring up between Six and Twelve at night, and laſt 'till Six, Eight or Nine in the Morning.

is equal to the Weight of *twenty thouſand* Pounds. Tremendous Conſideration! Should an Houſe fall upon us with half that Force, it would break every Bone of our Bodies. Yet ſo admirably has the Divine Wiſdom contrived the Air, and ſo nicely counterpoiſed its dreadful Power; that we ſuffer no manner of Inconvenience; we even *enjoy* the Load. Inſtead of being as a Mountain on our Loins, it is as Wings to our Feet, or Sinews to our Limbs. Is not this *common* Ordination of Providence, ſomewhat like the Miracle of the burning Buſh? Well may we ſay unto GOD, O how terrible, yet how beneficent art thou in thy Works!

THE Air, tho' too weak to ſupport *our* Flight, is a thoroughfare for innumerable Wings. Here the whole Commonwealth of Birds expatiate, beyond the reach of their Adverſaries. Were they to run upon the Earth they would be in ten thouſand Dangers without Strength to reſiſt, or Speed to eſcape them: Whereas by mounting the Skies they are ſecure from Peril, they *ſcorn the horſe and his rider*. Some of them perching on the Boughs, or ſoaring aloft, entertain us with their Notes. Many of them yield us wholſome and agreeable Food, and yet give us no trouble, put us to no Expence, but till the time we want them, are wholly out of the way.

THE Air is charged alſo with ſeveral Offices, abſolutely needful for Mankind. In our Lungs it *ventilates* the Blood, qualifies its Warmth; promotes the Animal Secretions. We might live even Months, without the Light of the Sun, yea, or the Glimmering of a Star. Whereas if we are deprived but a few Minutes of This, we ſicken, we faint, we die. The ſame *univerſal Nurſe* has a conſiderable ſhare in cheriſhing the ſeveral Tribes of Plants. It transfuſes vegetable Vigour into the Trunk of an Oak, and a blooming Gaiety into the Leaves of a Roſe.

THE Air likewiſe conveys to our Noſtrils the extremely ſubtle *Effluvia* which exhale from odoriferous Bodies: Particles ſo ſmall, that they elude the moſt careful Hand. But this receives and tranſmits the inviſible Vagrants, without loſing even a ſingle Atom: Entertaining us with the delightful Senſations that ariſe from the Fragrance of

Flowers and admoniſhing us to withdraw from an unwholſome Situation, to beware of pernicious Food.

The Air by its undulating Motion conducts to our Ear all the Diverſities of *Sound*. While Danger is at a conſiderable Diſtance, this advertiſes us of its Approach; and with a clamorous but kind Importunity, urges us to provide for our Safety.

The Air wafts to our Senſe all the Modulations of *Muſic*, and the more agreeable Entertainments of Converſation. It diſtributes every Muſical Variation with the utmoſt Exactneſs, and delivers the Meſſage of the *Speaker* with the moſt punctual Fidelity: Whereas without this Internuntio, all would be ſullen and unmeaning Silence. We ſhould neither be charmed by the harmonious, nor improved by the articulate Accents.

How gentle are the Breezes of the Air when unconfined! But when collected, they act with ſuch immenſe Force, as is ſufficient to whirl round the hugeſt Wheels, tho' clogged with the moſt incumbering Loads. They make the ponderous Millſtones move as ſwiftly, as the Dancers Heel; and the maſſy Beams play as nimbly, as the Muſicians Finger.

In the higher Regions there is an endleſs Succeſſion of *Clouds*, fed by Evaporations from the Ocean. The Clouds are themſelves a kind of Ocean, ſuſpended in the Air. They travel in detached Parties, over all the terreſtrial Globe. They fructify by proper Communications of Moiſture the ſpacious Paſtures of the Wealthy, and gladden with no leſs liberal Showers, the Cottagers little Spot. Nay they *ſatisfy the deſolate and waſte Ground, and cauſe the bud of the tender herb to ſpring forth:* That the Natives of the lonely Deſert, the Herds which know no Maſter's Stall, may nevertheleſs experience the Care of an all-ſupporting Parent.

How wonderful! That *pendent Lakes* ſhould be diffuſed, fluid Mountains heaped over our Heads, and both ſuſtained in the thinneſt Parts of the Atmoſphere. How ſurprizing is the Expedient which without Veſſels of Stone or Braſs, keeps ſuch Loads of Water in a buoyant State? *Job* conſidered this with holy Admiration. *Doſt thou know the Balancings of the clouds?* How ſuch ponderous Bodies are made to hang in even poiſe, and hover like the lighteſt Down? *He bindeth up the waters in his thick cloud: And the cloud,* tho' nothing is more looſe and fluid, becomes by his Order tenacious as Caſks of Iron, *is not rent* under all the Weight.

When the Sluices are opened and the Waters deſcend, one would think they ſhould pour down in Torrents: Whereas inſtead of this, which would be infinitely pernicious, they coaleſce into *Globules*, and are diſpenſed in gentle *Showers*. They ſpread themſelves as if ſtrained thro' the Orifices of the fineſt Watering-Pot, and form thoſe *ſmall drops of rain,* which the clouds *diſtil upon man abundantly.* Thus inſtead of drowning the Earth, and ſweeping away its Fruits, they cheriſh univerſal Nature, and (like their Great Maſter) diſtribute their Stores, to Men, Animals, Vegetables, *as they are able to bear them.*

But beſide Waters, here are cantoned various Parties of Winds, mild or fierce, gentle or boiſtrous, furniſhed with breezy Winds, to *fan* the glowing Firmament, or elſe fitted to act as an univerſal *Beſom*, and by ſweeping the Chambers of the Atmoſphere to cleanſe the fine äereal Fluid. Without this wholſome Agency of the Winds, the Air would ſtagnate and become putrid: So that all the great Cities in the World, inſtead of being Seats of Elegance, would degenerate into Sinks of Corruption.

At Sea, the Winds ſwell the Mariner's Sails, and ſpeed his Courſe along the watry Way. By Land they perform the Office of an immenſe *Seeds-man*, ſcattering abroad the Seeds of numberleſs Plants, which tho' the Support of many Animals, are too ſmall for the Management, or too mean for the Attention of Man.

Here are *Lightnings* ſtationed, in act to ſpring, whenever their piercing Flaſh is neceſſary, either to deſtroy the *ſulphureous* Vapours, or diſlodge any other *noxious* Matter, which might prejudice the delicate Temperature of the Ether, and obſcure its more than chryſtalline Tranſparency.

Above all is ſituate a radiant and majeſtic Orb, which inlightens and chears the Inhabitants of the Earth: While the Air, by a ſingular Addreſs, amplifies its Uſefulneſs. Its *reflecting* Power augments that Heat, which is the Life of Nature: Its *refracting* Power prolongs that Splendor, which is the Beauty of the Creation.

I say, *Augments the Heat*. For the Air is a *Cover*, which without oppreſſing us with any perceivable Weight, confines, reflects, and thereby increaſes, the vivifying Heat of the Sun. The Air increaſes this, much in the ſame manner as our Cloaths give additional Heat to our Body: Whereas when it is leſs in Quantity, when it is attenuated, the Solar Heat is very ſenſibly diminiſhed. Travellers on the lofty Mountains of *America*, ſometimes experience this to their Coſt. Tho' the Clime at the foot of thoſe vaſt Mountains, is extremely hot and ſultry, yet at the Top, the Cold is ſo exceſſive, as often to freeze both the Horſe and Rider to Death. We have therefore great Reaſon to praiſe God, for placing us in the commodious Concavity, the cheriſhing Wings of an Atmoſphere.

The Emanations of *Light*, tho' formed of inactive Matter, yet (Aſtoniſhing Power of divine Wiſdom!) are refined almoſt to the *Subtilty* of Spirit, and are ſcarce inferior even to Thought in *Speed*. By which means they ſpread with almoſt inſtantaneous Swiftneſs, thro' an whole Hemiſphere: And tho' they fill whatever they pervade, yet they ſtraiten no Place, embarraſs no one, incumber nothing.

Every where indeed, and in every Element we may diſcern the Footſteps of the Creator's Wiſdom. The ſpacious Canopy over our heads is painted with Blue; and the ample Carpet under our feet is tinged with Green. Theſe Colours, by their ſoft and chearing Qualities, yield a perpetual Refreſhment to the Eye. Whereas had the Face of Nature gliſtened with White or glowed with Scarlet, ſuch dazling Hues, inſtead of chearing, would have fatigued the Sight. Beſides, as the ſeveral brighter Colours are interſperſed, and form the Pictures in this magnificent Piece, the Green and the Blue make an admirable *Ground*, which ſhews them all to the utmoſt Advantage.

HAD the Air been much *groſſer*, it would have dim'd the Rays of the Sun and darkened the Day. Our Lungs would have been clogged in their vital Functions, and Men drowned or ſuffocated therein. Were it much more *ſubtle*, Birds would not be able to wing their way thro' the Firmament: Neither could the Clouds be ſuſtained, in ſo thin an Atmoſphere. It would elude likewiſe the Organs of Reſpiration: We ſhould gaſp for Breath with as much Difficulty, and as little Succeſs as Fiſhes do, when out of their native element.

THE *Ground* alſo is wrought into the moſt proper Temperature. Was it of a *firmer* Conſiſtence, it would be impenetrable to the Plough, and unmanageable by the Spade. Was it of a more *looſe* Compoſition, it would be incapable of ſupporting its own Furniture. The light Mould would be ſwept away by whirling Winds, or ſoaked into Sloughs by the deſcending Rains. Again, becauſe every Place ſuits not every Plant, but that which nouriſhes One, deſtroys another; the Qualities of the Earth are ſo abundantly diverſified, as to accommodate every Species. We have a Variety of intermediate Soils, from the *looſe* Sand to the *ſtiff* Clay: from the rough Projections of the craggy Rock, to the ſoft Bed of the ſmooth Parterre.

THE *Sea* carries equal Evidences of a moſt wiſe and gracious Ordination. Was it *larger*, we ſhould have wanted Land for Paſturage and Huſbandry. We ſhould not have had room for Mines and Foreſts, our ſubterranean Ware-houſes and äereal Timber-yards. Was it *ſmaller*, it could not recruit the Sky with a proper Quantity of Exhalations; nor ſupply the Earth with the neceſſary Quota of fructifying Showers.

MAY we not diſcover as exquiſite Strokes of Wiſdom in each individual Object? All that ſhines in the Heavens, and all that ſmiles on the Earth, ſpeak their infinitely wiſe Creator. Need we launch into the Praiſe of the Valleys clothed with Graſs, or of the Fields, repleniſhed with Corn? Even the ragged

Rocks, which frown over the Flood, the caverned Quarries which yawn admidſt tne Land, together with the ſhapeleſs and enormous Mountains, which ſeem to load the Ground and incumber the Skies ; even theſe contribute to increaſe the General Pleaſure, and augment the general Uſefulneſs. They add new Charms to the wide Level of our Plains, and ſhelter like a Screen the warm Lap of our Vales.

Who is not charmed with the delicious Fruits of Summer and Autumn ? But were all our Trees and Shrubs to produce ſuch Fruits, what would become of the Birds ? How ſmall a Part would voracious Man reſign to their Enjoyment ? To provide therefore for each Vagrant of the Air, as well as for the Sovereign of a Nation, there is in all Places a large Growth of Shrubs, annually covered with coarſe and hardy Berries : So coarſe in their Taſte, that they are unworthy the Acceptance of Man ; ſo hardy in their Make, that they endure the utmoſt Severity of the Weather, and furniſh the feathered Tribes with a ſtanding Repaſt amidſt all the Deſolations of Winter.

The Fir, the Beech, the Elm, are ſtately Decorations of our rural Seats. But if there were no intangling Thickets, no prickly Thorns, where would the Farmer procure Fences ? How could he ſecure his vegetable Wealth, from the Flocks and the Herds ? Thoſe roving Plunderers, which ſubmit to no Laws, but thoſe of the coercive kind.

We ſpare no Toil, to have uſeful Herbs and Plants, in our Gardens, and upon our Tables. But there are innumerable Herbs, which paſs under the contemptible Character of *Weeds*, and yet are full as deſirable to other Claſſes of Creatures, as theſe are to Mankind. Yet who will be at the pains, to plant, to water, to cultivate, ſuch deſpicable Productions ? Man would rather *extirpate* than propagate, theſe Incumbrances of his Land. Therefore Providence vouchſafes to be their Gardiner, and has wrought off their Seeds with ſuch a Lightneſs, that they are tranſported to and fro, by the mere Undulations of the Air. Or, if too heavy to be wafted by the Breeze, they are faſtened to

Wings of Down : Or elſe, incloſed in a ſpringy Caſe, which forcibly burſting, ſhoots them out on every ſide. By ſome ſuch Means, the re-producing Principle of every one is diſſeminated, the univerſal Granary filled, and the univerſal Board furniſhed. The buzzing Inſect and the creeping Worm, have each his Bill of Fare. Each enjoys a never-failing Treat, equivalent to our greateſt Delicacies.

If *Graſs* was as ſcarce as the *Guernſey-lilly*, and as difficultly raiſed as the *Tuberoſe*, how certainly, and how ſpeedily, muſt many Millions of Animals periſh by Famine? But as all the Cattle owe their chief Subſiſtence to This, by a ſingular Wiſdom in the Divine Œconomy, *it waiteth not*, like the Corn-field, and the Garden-bed, *for* the annual Labours of *Man*. When once ſown, tho' ever ſo frequently cropt, it revives with the returning Seaſon. With a kind of perennial Verdure, it covers our Meadows, diffuſes itſelf over the Plains, ſprings up in every Glade of the Foreſt, and ſpreads a Side-board in the moſt ſequeſtered Nook.

Such is the Care of a wiſe and condeſcending Providence, even over theſe loweſt Formations of Nature!

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Part the Fifth.

Of the Syſtem *of the* World; *of the* Heavenly Bodies; *and of the* Properties *and* Cauſes *of* Natural Bodies.

CHAP. I.

Of the Syſtem of the World.

1. *The General Phœnomena of the Sun and Moon:*
2. *Of Mercury and Venus:*
3. *Of the other Planets:*
4. *Of the Comets and fixt Stars:*
5. *The Ptolemaïc Syſtem:*
6. *The Copernican:*
7. *The Syſtem of Tycho Brahe:*
8. *The Hutchinſonian Syſtem.*

1. HAVING conſidered the Earth, with the Bodies that are therein, let us now look up to thoſe that ſurround it. The World is a Congeries of innumerable Bodies, many of which are ſuppoſed to equal or exceed the Size of the Earth: Yet by reaſon of their diſtance, moſt of them are inviſible to the naked Eye.

The neareſt to us is the *Moon*, which moves round the Earth in ſomething more than 28 days from Weſt to Eaſt. The *Sun* likewiſe ſeems to move from Eaſt to Weſt, and ſhines ſucceſſively on all Parts of the Globe. It appears alſo to us to move every year obliquely from Weſt to Eaſt, coming 23 degrees and an half to the North, and then going juſt as far to the South.

2. Some of the *Stars* keep always the ſame diſtance, with reſpect to each other, and are termed *Fixt*. Others are continually changing their Situation, whence they are termed *Planets*. Two of theſe, *Mercury* and *Venus*, are frequently between the Earth and the Sun. Of which the former, being generally hid by the Rays of the Sun, is ſeldom viſible: But *Venus*, commonly called the *Evening Star*, is very conſpicuous. The *Earth* is never between Them and the Sun. They are ſometimes between us and him. Sometimes the Sun is interpoſed between us and them.

3. The upper Planets are *Mars*, *Jupiter* and *Saturn*. The Sun is ſometimes beween theſe and the Earth. But none of them is ever interpoſed between the Earth and the Sun. *Mars* has different Appearances, like the Moon as it is differently ſituated, with regard to the Sun: Whereas Jupiter and Saturn always appear with the ſame Aſpect, and have ſmaller Planets revolving round them. All theſe revolve round the Sun, in their ſeveral ſtated Periods.

4. Beside theſe, there is another kind of Stars called *Comets*, vulgarly *Blazing Stars*. Theſe do not revolve round the Sun, in ſo regular Orbits as the Planets: The *fixt Stars* are above theſe: About 2200 are viſible to the naked Eye. They have a vivid Light, and always appear with the ſame Face toward us: They ſeem to have a two-fold Motion, a ſlow one from Eaſt to Weſt in a Year, and a ſwift one round the Earth with all the other Stars in four and twenty Hours. But there are ſome of them which never ſet, namely thoſe near the North or South Pole.

5. To explain theſe Phænomena of the Heavenly Bodies, various Syſtems have been invented. The *Ptolemaic* ſuppoſes the Earth to be fixt in the Center of

the Univerſe, round which all the heavenly Bodies move, each affixt to a ſolid Sphere which moves with that: Firſt the Moon, then Mercury, thirdly, Venus, next the Sun, fifthly Mars, then Jupiter, ſeventhly, Saturn. In the Eighth place is the *Firmament* or Sphere of fixt Stars: Then the *Chryſtalline Heaven*, and laſt of all the *Primum Mobile*, which is ſuppoſed to move from Eaſt to Weſt in 24 hours, whirling all the other Spheres with it. But this Syſtem, being in ſome reſpects obviouſly falſe, in others utterly improbable, and likewiſe inſufficient to account for many Phænomena, is now univerſally exploded.

6. In the room of this the *Copernican* Syſtem is now generally received, which ſuppoſes the Sun to be fixt in the Center, without any other Motion, than that round his own Axis. Next him is Mercury, then Venus, thirdly the Earth, (round which the Moon revolves;) Above the Earth, Mars, then Jupiter and Saturn, with their attendant Moons. This Syſtem is extremely ſimple and natural, and eaſily accounts for moſt Phænomena. As to the Objection, that it is contrary to the teſtimony of our Senſes, it is eaſily anſwered. They who are in a Ship ſeem to ſee the Shore and the Land moving along, altho' it is really the Ship that moves Yet let it move ever ſo ſwiftly, it diſplaces nothing provided it move ſmoothly. So neither does the Motion of the Earth diſplace any thing on its Surface, becauſe it is equable and regular.

Not that *Copernicus* was the Inventor of this Syſtem. It was in great part known long ago. *Pythagoras* taught, "that the Earth was carried about the Sun among the Stars, and by turning round its Axis, cauſed day and night." Yet by degrees it ſunk into oblivion, till it was revived by Cardinal *Cuſa*. However the *Ptolemaic* Syſtem ſtill prevailed, till *Nicholas Copernicus*, a Canon of *Thorn*, in *Poliſh Pruſſia*, born in the year 1473, had Reſolution to examine it thro'ly, and Learning enough to explain and defend it. Some of the Reaſons on which this Syſtem is founded are, 1. This is moſt ſimple, and agreeable to the whole Tenor of Nature: For by the two Motions of the Earth all the Phænomena of the Heavens are reſolved, which on any of the other Hypotheſes are utterly inexplicable. 2. It is more rational to ſuppoſe the Earth moves round the Sun, than that the huge Bodies of the Planets and of the Sun itſelf, and the immenſe Firmament of Stars, ſhould all move round the inconſiderable Body of Earth every four and twenty Hours. 3. The Earth's moving round the Sun is agreeable to that general Harmony and univerſal Law, which all other moving Bodies of the Syſtem obſerve, namely, that the Squares of the periodical Times are as the Cubes of the Diſtances. But if the Sun move round the Earth, that Law is deſtroyed, and the general Order and Symmetry of Nature interrupted; becauſe according to that Law, the Sun would be ſo far from revolving about the Earth in 365 Days, that it would require no leſs than 5196 Years, to finiſh one Revolution. 4. The Sun is the Fountain of Light and Heat, which it darts thro' the whole Syſtem, and therefore it ought to be placed, as the Heart in the Center, that ſo all the Planets may at all times have them, in an uniform and equal manner. 5. If the Sun be placed in the Center of the Syſtem, we have then the rational Hypotheſis, of the Planets being all moved about the Sun, by the univerſal Law of Gravity: And every thing will anſwer to that Law; but otherwiſe we are wholly in the dark. 6. But we need not rely upon Conjectures. We have demonſtrative Proofs, that the Sun poſſeſſes the Center, and that the Planets move round it, in the Order above mentioned. For example. *Mercury* and *Venus* are ever obſerved to have two Conjunctions with the Sun but no Oppoſition, which could not happen unleſs the Orbits of thoſe Planets lay within the Orbit of the Earth. And in the ſame manner it may be demonſtrated, that the Orbits of *Mars*, *Jupiter* and *Saturn*, lie without the Orbit of the Earth.

7. After *Copernicus* came *Tycho Brahe*, a noble *Dane*, who endeavoured to compound a Syſtem of the *Ptolemaic* and *Copernican* put together. But it was quickly found by all unprejudiced Judges, to be ſo intricate and perplext, that it had not many Aſſerters even while he lived, and is now well nigh ſunk into oblivion.

8. Mr. *Hutchinſon* (not the Profeſſor of *Glaſgow*, but a private *Engliſh* Gentleman) ſuppoſes the conſtituent Parts of Heaven to be, 1. The *Darkneſs*, or dark Air, which is no other than the fine Ether, in a State of Stagnation: 2. The *Spirit*, or the Air in a ſenſible Motion: 3. The *Light*, the fineſt Part of the Heavens, the pure Ether in motion: 4. The *Luminaries* and their *Fluxes*. Underſtand by the Luminaries the *Bodies* of the Sun, Moon and Stars; by their *Fluxes*, the flow of light that comes from each of them. Revelation conſtantly diſtinguiſhes theſe. Therefore 'tis very improper for us to confound them together. Indeed every one knows, that tho' the Bodies of the Sun, Moon and Stars, take up but a ſmall Part of the Heavens, yet the Fluxes of Light from them diffuſe themſelves throughout all Nature.

The ſpringing forth of the ſolar Light cauſes the Morning, its going off, the Evening. Its being intercepted by the Body of the Earth cauſes *Night*; its Shining cauſes *Day*. It acts in a mechanical way, and is part of the great Machine of Nature. It is in continual Motion to and from the body of the Sun: Going out from the Center to the Circumference of the Heavens, and returning to the Center again. The ſolar Light, along with the Spirit, which continually attends it, is the Cauſe of the regular Returns of Morning and Evening, Summer and Winter. The Spirit and Light are properly the Agent, and the Earth only the Patient. Its Motion round its Axis, and round the Sun, and its inclining Northward and Southward at different times, are all produced by the Action of the Light going outward, and the Spirit returning inward. 5. The *Denſities*, which form the Extremity of the whole Syſtem of Nature; the denſe, groſs Air, out of which the fine Ether is extracted and into which it returns. The Heavens which naturally be groſſer and groſſer, the farther from the Sun, 'till perhaps at the utmoſt extremity, they are condenſed into an immovable Solid.

These are the conſtituent Parts of the Heavens. And hence we have reaſon to conceive, that all theſe

Parts, (the Sun, Moon and Stars excepted) are no other than the different States into which the ethereal Fluid does or may paſs. For the *Darkneſs* is the fine Atoms of the Heaven in a State of Inactivity. The *Spirit* is the groſſer Parts of the Heavens or maſſes compreſt together; while the *Light* is the Atoms or fineſt Part of the Ether in ſwift Motion. At the Center the Commotion is greateſt, and gradually decreaſes toward the Circumference, where the Ether is very much condenſed and this is called the *Denſity*."

He farther ſuppoſes, that the Sun is the Center of the whole Univerſe; that the fixt Stars are all placed in the Denſity, not far from each other, and abundantly nearer the Earth, than common Aſtronomers imagine, and that their Uſe, is not to perform the Office of Suns to other Planets, but to aſſiſt in that cold Region, to ſupply in ſome degree the Want of the ſolar Fire.

Perhaps it may not be unacceptable to the ſerious Reader, to give a more particular account of this ingenious Hypotheſis, in the words of a late Writer. The Sum of what Mr. *Hutchinſon* avers, is, That beſide the differently-formed Particles of which the Earth, and the ſeveral ſolid Subſtances in it, and in the other Orbs, are compoſed, God at firſt created all that ſubtle Fluid which now is, and from the Creation has been, in the condition of *Fire*, *Light* or *Air*, and goes under the name of *the Heavens*.

The Particles of this Fluid (which he calls Atoms) when they are ſingle and uncompounded, are inconceivably minute, and ſo ſubtle as to pervade the Pores of all Subſtances whatever, whether ſolid or fluid. When they are puſhed forward in ſtrait lines, by the action of Fire, or are reflected or refracted in ſtrait lines, they produce *Light*, and are ſo called. When the interpoſition of opake Bodies hinders their Progreſs in ſtrait lines, they paſs, but ceaſe to produce Light.

These Particles, which when moving in ſtrait lines produce Light, and when collected and put into another ſort of motion, produce Fire, when the force impelling them ceaſes to act with vigour, and when their Motion is retarded, cohere in ſmall Maſſes or Grains, which Mr. *Hutchinſon* calls *Spirit* or *Air*, and is of the ſame kind and texture, with that Air which we daily breathe.

THE Sun, fixt at the Center of this Syſtem, is included in a vaſt Collection of this ſubtle matter, in the form of Fire, which continually melts down all the Air that is brought into it from all Parts of the Syſtem, into Atoms, and with an immenſe force ſends it forth, in perpetual Streams of Light, to the Circumference. The whole Space comprehended within this, is abſolutely full.

THE matter thus melted down at the Orb of the Sun, moves outward to the Circumference, being forced by the Particles which are concreted into Air at the utmoſt Extremities, and return toward the Sun, where the fluid being moſt ſubtle gives leaſt reſiſtance, and takes up the place that the Light left.

AND therefore this uninterrupted Flux of matter from the Sun in Light, in place of being an Expence which would neceſſarily deſtroy that Orb (an inſupportable Objection, Mr. *Hutchinſon* thinks, to Sir *Iſaac Newton*'s Scheme) is the very means of preſerving it, and every thing elſe in this Syſtem, in its action, and vigour, by preſſing back perpetual Supplies of Air to be melted down into Light, which produces a continual Circulation. Theſe perpetual tides of matter outwards and inwards, in every point, from the center to the circumference, produce that conſtant Gyration in the Earth and the Planets round their own Centers and round the Sun.

BESIDES the Rotation of the Orbs, the adverſe Motion of the Light puſhing toward the Circumference, and the Air puſhing toward the Center with immenſe force, brings that Compreſſure on all the bodies it meets, that binds together ſolids, keeps fluids as they were, cauſes the raiſing of water, the production of vegetables and animals, and in ſhort produces all the Effects uſually aſcribed to Gravitation or Attraction; continues Motion without the aſſiſtance of the unmechanical principle of Projection. and is indeed the real Cauſe of almoſt all the effects and phænomena in Nature,

As immenſely different as this is, from all the other Syſtems of Aſtronomy, very probable Arguments are alledged in confirmation of it. And more than probability, I doubt, we ſhall never attain, with regard to things at ſo great a diſtance from us.

CHAP. II.

Of the Heavenly Bodies in particular.

1. *Of the Sun*,
2. *Mercury*,
3. *Venus*,
4. *The Earth*,
5. *The Moon* :
6. *Of Mars*,
7. *Jupiter*,
8. *Saturn*,
9 *Comets*,
10. *The fixt Stars* :
11. *Reflections*.

1. THE very ſame Effects which we obſerve daily in *Fire*, we obſerve alſo in the *Sun*. It ſhines, it warms, it burns. Viewed with a Teleſcope it appears, like an Ocean of Fire or melted Metal. Hence many ſuppoſe, that the Spots appearing thereon and changing continually, are as it were the Droſs and Scum of that Metal, which it throws out from time to time. But 'tis more probable, ſome of thoſe Spots are Clouds, formed out of the Solar Exhalations. And if Exhalations riſe out of his Body, and are ſuſpended at a certain Height from it, then the Sun muſt be incompaſt with a Fluid, analogous to our Atmoſphere. Some of theſe Spots diſſolve and diſappear, in the very middle of the Suns Diſk : that is, the Exhalations ſometimes riſe, ſometimes fall back to the

Sun. [q] But there is another kind of Spots, which regularly revolve, once in ſeven and twenty Hours. Or, to ſpeak more properly, the Sun himſelf revolves in that time, round his own Axis, together with his Atmoſphere. And hence it is, that thoſe Spots being viewed obliquely near the Edge of the Sun, appear narrow and oblong. He is ſuppoſed to be abundantly larger than the Earth. When the Moon paſſes between the Earth and the Sun, ſo as to intercept his Rays, he is ſaid to be *eclipſed*. This happens only at the time of the New Moon, becauſe it is then only ſhe paſſes between the Sun and the Earth. Yet not at every New Moon, becauſe ſhe generally declines either to the North or South.

No Solar Eclipſe can be univerſal, the Moon being too little to overſhadow the whole Earth. Nor does any Eclipſe appear the ſame in all Places, but is total in One and partial in another. In moſt Solar Eclipſes, the Moon is covered with a faint, dawning Light, which is owing to the Reflection of the Light from the illuminated Parts of the Earth. In total Eclipſes the Moon's Edge is ſeen ſurrounded by a pale Circle of Light, which is at leaſt a probable Indication of a Lunar Atmoſphere.

WHEN the Earth is interpoſed between the Moon and the Sun, then the Moon is eclipſed. This is only at the time of the full Moon. Even in the midſt of the Eclipſe the Moon has a faint Light, which is reflected by the Atmoſphere of the Earth. And to the Shadow of this it is owing, that ſhe grows paler and dimmer, before ſhe enters into the Shadow of the Earth.

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[q] "WE are not ſure, ſays Mr. *Huygens*, whether the Sun be a ſolid or liquid Globe. I rather think it liquid, which the equal Diſtribution of his Light to all parts is an argument for. That very ſmall Inequality on his Surface, diſcovered by the Teleſcope, which has made ſome men imagine they ſaw, huge Mountains of Fire, is entirely owing to the trembling Motion of the Vapours our Atmoſphere is full of, particularly near the Earth. And this is likewiſe the Cauſe, of the Stars Twinkling."

"THE dark Spots in the Sun I have often ſeen; but thoſe bright Spots of which many ſpeak, I never was able to diſcover: So that I cannot but doubt of their Exiſtence. Nor do I apprehend, there is any thing in or upon the Sun, brighter than the Sun itſelf. Indeed it is not pretended that theſe bright Spots are any where, but juſt about the dark ones. And it is no wonder, the Parts which are near the dark, ſhould appear ſomewhat brighter than the reſt."

2. The Planet neareſt to the Sun is *Mercury*, which is the ſmalleſt of all, ſuppoſed to be twelve times leſs than the Earth. It moves round the Sun in about three Months, and is believed to be the moſt denſe of all the Heavenly Bodies. It ſometimes moves between the Earth and the Sun. And from its various Appearances, we may certainly infer, that it has no Light of its own, but ſhines by reflection only.

3. The Next to Mercury is *Venus*, whoſe Appearances likewiſe change in the ſame manner as the Moon's. It is ſuppoſed to be ſomething leſs than the Earth, and compleats its Period round the Sun, in nearly ſeven Months. From its Situation we may judge, it is more denſe than the Earth, but more rare than Mercury.

4. Next to Venus is the *Earth*, which moves round its own Axis from Weſt to Eaſt in twenty four Hours, and round the Sun in 365 Days, five Hours and near forty-nine Minutes.

The Difference of Seaſons, as well as the different degrees of Heat and Cold, depend on the different Poſitions of the Earth with reſpect to the Sun. The natural State of this Globe, ſeems to be what we call Temperate. This is what ſecures Springs and other Bodies from being frozen. But the Obliquity and Perpendicularity with which the Rays of the Sun fall on the Air, are varying continually, according to which the Warmth of the Air is continually leſſening or increaſing. Likewiſe the Continuance of the Sun's Preſence, with the Slowneſs of his Motion, naturally increaſe Heat; as his Abſence and the Swiftneſs of his Motion, naturally increaſe Cold. Yet this Rule does not always hold. There are many Accidents that prevent it: Such as the Situation of Hills, and the declivity of Land, toward the North or South. Clouds alſo ſometimes reflect Heat, and Water Clouds cool the Air. South or South-Weſt

Winds, if without Rain, increaſe Warmth; Eaſt or Northerly Winds occaſion Cold. Whenever ſmooth Water reflects the Sun's Rays, it much increaſes Heat. And indeed all ſmooth Bodies which reflect Light, reflect Heat along with it, and that more or leſs, according to the Cloſeneſs of the Pores, and the Extent, Convexity or Concavity of their Surface.

ALL Parts of the Earth enjoy nearly the ſame Quantity of the Sun's Preſence in the ſpace of a Year. And yet how widely different is the Quantity of Heat, in ſome from that in others? But it is not, as any one would imagine, greateſt under the Line. This is prevented by the Swiftneſs of his Motion. For the nearer he approaches to it, the ſwifter is his Motion from Eaſt to Weſt, from North to South, and from South to North. He paſſes ſeven Degrees, from three and an half South Latitude, to three and an half North, in Eighteen Days: Whereas, at 20 degrees North Latitude, he ſpends an whole Month in going three degrees and an half, and another Month, in returning: So that he is as near the Tropic for 67 Days, as he was to the Line for Eighteen. And hence the Heat is conſiderably greater under the Tropic, than it is under the Line.

5. THE *Moon* moves round the Earth in about 28 Days, and with the Earth round the Sun in a Year. Yet it always turns the ſame ſide to the Earth, whence we always obſerve the ſame Inequalities in its Surface. It does not appear, that ſhe moves at all round her own Axis. None now doubts of the Moon's being an opake Body: And the Spots and Unevenneſſes, which conſtantly appear upon it, have been judged by ſome, to be Valleys, Mountains, Lakes and Seas.

HALF at leaſt of the Moon is always inlightened by the Sun. But as it is continually changing its Situation, the whole of the enlightened Part is not always towards us, and therefore ſhe exhibits to us various Appearances. When ſhe begins to recede from her Conjunction with the Sun, and to emerge out of his Rays, a ſmall Portion of her inlightened Part is ſeen, and appears, as it were, horned. But the farther ſhe recedes from the Sun, the more of the enlightned Part appears, 'till about the fourteenth Day, being juſt oppoſite to him, ſhe ſhews us her entire Hemiſphere. In the ſame manner ſhe appears to decreaſe, while ſhe is approaching the Sun. The Moon is ſuppoſed to be forty-five times ſmaller than the Earth.

THE Moon has ſometimes diſappeared in a clear Sky, ſo as not to be diſcoverable by the beſt Glaſſes. This *Keplar* obſerved in the year 1580 and in 1583: *Hevelius* in 1620, as did *Ricciolus*, and many others at *Bologna*. Many People throughout *Holland* obſerved the ſame, *April* 14, 1642. *December* 23, 1703 there was another total Obſcuration. A little before it, ſhe appeared at *Arles* of a yellowiſh Brown, at *Avignon* ruddy and tranſparent. At *Marſeilles*, one Part was ruddy, the other duſky, 'till ſhe wholly diſappeared. I do not find, that the boldeſt Philoſophers attempt to account for this.

IT is now almoſt univerſally ſuppoſed, that the Moon is juſt like the Earth, having Mountains and Valleys, Seas with Iſlands, Peninſula's and Promontories, and a changeable Atmoſphere, wherein Vapours and Exhalations riſe and fall. And hence it is generally infered, that She is inhabited like the Earth, and by Parity of Reaſon, that all the other Planets, as well as the Earth and Moon, have their reſpective Inhabitants. But after all comes the celebrated Mr. *Huygens*, and brings ſtrong Reaſons, why the Moon is not and cannot be inhabited at all, nor any Secondary Planet whatever. Then I doubt we ſhall never prove that the Primary are: And ſo the whole ingenious Hypotheſis, of innumerable Suns and Worlds moving round them, vaniſhes into Air.

IT may not be unacceptable to the Reader, to ſee the Sum of his Reaſonings on this head. "One would think that the Moon which is ſo near us, and may by a Teleſcope be ſo accurately obſerved, ſhould afford us matter of more probable Conjecture, than any of the remoter Planets. But it is quite otherwiſe. Only this we may venture to ſay, that all the Attendants of Jupiter and Saturn are of the ſame nature with our Moon, as going round them, and being carried with them round the Sun, juſt as the Moon is with the Earth. Therefore whatever we may reaſonably affirm or conjecture, with regard to our Moon, muſt be ſuppoſed, with very little alteration to belong to the Satellits of Jupiter and Saturn.

The Surface of the Moon is found, even when we uſe the ſhorteſt Teleſcopes, to be diverſified with long Tracts of Mountains and again with broad Valleys. For in thoſe Parts oppoſite to the Sun, you may ſee the Shadows of the Mountains, and often the round Valleys between them, with an Hill or two riſing out of them. But I cannot find any thing like Sea there, notwithſtanding what many affirm. For thoſe vaſt Countries which appear darker than the others, commonly taken for Seas, are diſcovered with a good long Teleſcope, to be full of little round Cavities: The ſhadow of which, falling within themſelves, makes them appear of that Colour. And thoſe large Champains, if you look carefully upon them, you will find not to be always ſmooth and even. Now neither of theſe things can agree to the Sea. Therefore it is far more probable, that thoſe Plains in her which ſeem brighter than the other Parts, conſiſt of a whiter ſort of Matter. Nor do I believe, that there are any Rivers: For if there were, they could never have eſcaped our Obſervation: Eſpecially if they run between the Hills, as our Rivers do. Nor have they any Clouds to furniſh Rivers with Water. For if they had, we ſhould ſometimes ſee one Part of the Moon darkened by them and ſometimes another, whereas we have always the ſame Proſpect of her.

“ Tis certain moreover, that the Moon has no Air or Atmoſphere ſurrounding it. For then we could never ſee the very outermoſt Rim of the Moon ſo exactly as we do when any Star goes under it, but its Light would terminate in a faint, gradual Shade, and there would be a ſort of Down as it were about it. Not to mention, that the Vapours of our Atmoſphere conſiſt of Water; and conſequently where there are no Seas, there can be no ſuch Atmoſphere. This is the grand Difference between the Moon and us. Were there Seas and Rivers therein, we might eaſily believe that it had all the other Furniture which belongs to our Earth. But how can Plants or Animals, all whoſe Nouriſhment comes from liquid Bodies, thrive in a dry, waterleſs Soil?"

"Does then the Moon ſerve for nothing but to give us Light in the Night, and to raiſe the Tides in the Sea? And do all thoſe Moons round Jupiter and Saturn, anſwer no other purpoſe? I do not know what to ſay, becauſe I know of nothing like them to found a conjecture upon. Perhaps they may have ſome Plants and Animals, which have ſome Nouriſhment of a different kind from ours. Perhaps they may have Moiſture enough to cauſe a Miſt or Dew, which may ſuffice for the Herbs that grow there. But theſe are mere Gueſſes, or rather Doubts. And yet they are the beſt we can make, concerning either our own Moon, or thoſe which attend Jupiter and Saturn."

6. *Mars*, as well as Venus, Mercury and the Moon, has various Appearances, more or leſs full, as it is variouſly placed, with regard to the Sun and the Earth. Spots are obſerved on his Surface alſo, from the regular Motion of which we learn, that he revolves round his Axis from Weſt to Eaſt, in twenty four Hours and forty Minutes. He moves round the Sun in two Years, and is thought to be Eight times ſmaller than the Earth.

7. *Jupiter* is incompaſt from Weſt to Eaſt with two or three lucid *Belts*, not always appearing alike. In one of them a ſpot is conſtantly obſerved; and they regularly move from Weſt to Eaſt. Hence we learn, that he revolves round his Axis, which he does in Nine Hours and fifty-ſix Minutes. He is likewiſe attended by four ſmaller Planets or *Satellits*, like our Moon. Each of theſe moves round him in its ſtated Period, and all move with him round the Sun in twelve Years. Jupiter is ſuppoſed to be twenty-five times larger than the Earth.

8. The higheſt Planet, *Saturn* is incompaſt with a broad *Ring*, which is not contiguous to his Body, but is ſuſpended over him equally diſtant from every Part of his Surface. He has five Satellits or Moons, moving round him in their ſtated Periods. [r] Saturn himſelf revolves with them round the Sun in about thirty Years. He is ſuppoſed to be fifteen times bigger than the Earth.

If we compute the Magnitude of the Planets in number of Miles, the Diameter of the Moon is ſuppoſed to be 2175 miles, that of Mercury, 2748, that of Mars 4875, of the Earth (and nearly of Venus) 7967, of Saturn 93451, of Jupiter 130653; and that of the Sun 822148.

With regard to their Diſtance from the Earth, there is ſuch an immenſe Difference in the Calculations of Aſtronomers, even with reſpect to the Diſtance of the Sun (which ſome *demonſtrate* to be Ninety Millions of Millions, others to be not three Millions from the Earth :) that it is wiſeſt to confeſs our Ignorance, and to acknowledge we have nothing to reſt on here, but mere, uncertain Conjecture.

9. *Comets* are opake Bodies, which emit numerous Rays, ſometimes forward, ſometimes backward, ſometimes all round the Body of the Comet. Now they ſink near the Body of the Sun: Then they riſe far beyond the Orb of Saturn. Some ſuppoſe them to be imperfect Planets, or ſuch a Chaos of unformed Matter, as may hereafter be formed into an Earth like Ours. Probably thoſe Rays which they emit, are only Vapours by which the Rays of the Sun are refracted to us.

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[r] The brighteſt of theſe, which is the fourth, was firſt diſcovered by Mr. *Huygens*, in the year 1655. The reſt were diſcovered by *Caſſini*. And I have reaſon to think, ſays Mr. *Huygens*, there are one or two more ſtill behind. For between the fourth and fifth there is a diſtance not at all proportionable to that between all the others. Here it is probable, there may be a Sixth. And there may not improbably be another, without the Fifth, which has hitherto eſcaped us. For we can never ſee the Fifth but in that Part of its Orbit, which is toward the Weſt.

Hence they have a different Appearance, according as they are differently ſituated with regard to the Comet: Which is hereby confirmed, that the nearer they are to the Sun, the more thoſe Rays are increaſed, and the farther they recede from it, the more thoſe are diminiſhed. And hence ſome imagine, that Fixt Stars, covered with Vapours and Spots, become Comets. It is more probable, that Comets, like Planets, have their regular Periods: Altho' they frequently eſcape our Obſervation, as not revolving but in a long term of Years.

They are diſtinguiſhed from other Stars by a large Train of Light, which is always oppoſite to the Sun, and grows fainter and fainter, the farther it is from the Body of the Comet. When a Comet moves from the Sun, it is ſaid to be *bearded*, becauſe that Light is ſeen before it. When it moves toward the Sun, the Train follows it, and is called its *Tail.* When the Comet and Sun are oppoſite, (the Earth being between them) the train is hid behind the Body of the Comet, except a little that appears round it, and is termed its *Hair.* [s]

Comets ſeem to be a peculiar kind of Planets, which move in very oblique Orbits, and perſevere in their Motions, even againſt the Courſe and Direction of the other Planets. Their Tails are doubtleſs Vapours emitted by the Comet when heated by the Sun. Yet they do not aſcend ſwiftly from it, and then preſently diſappear; but are permanent Columns of Exhalations, gathered from the Comet by a gentle Motion,

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[s] Sir *Iſacc Newton* has proved, that the Heat of the Sun to the Comet in *Dec.* 1680, was to his Heat with us at Midſummer, as 28000 to One: And that the Heat of the Body of the Comet was near 2000 times greater than that of red-hot Iron.

After having acquired ſo immenſe an Heat, it muſt be a long time in cooling. Sir *Iſaac* computes, that a Globe of red-hot Iron 2000 times as large as the Earth, would ſcarce be cool in 50000 Years. If then the Comet be ſuppoſed to cool an hundred times as faſt as red-hot Iron, yet ſince its heat was two thouſand times greater, ſuppoſing it of the bigneſs of the Earth, it would not be cool in a Million of Years.

tion, and in a great Space of time, which then move with it thro' the celeſtial Regions.

ONE great Uſe of Comets probably is, to give Moiſture to the Planets. By their Vapours the Water ſpent in them, may be ſupplied and recruited. All Vegetables grow wholly from Fluids. But when they putrefy, great Part of them turns into dry Earth: Hence the Quantity of dry Earth muſt continually increaſe, and the Moiſture of the Globe decreaſe. Add to this, that immenſe Quantities of watry Vapours, are continually arreſted in the Polar Regions, and falling down form Mountains of eternal Snow, and Rocks of Ice that thaw no more. By both theſe Means the Moiſture of the Planets continually decreaſing, muſt in proceſs of time entirely fail, if it had not a ſeaſonable Supply, from ſome other Part of the Univerſe. Comets therefore are ſo far from being ſuperfluous, much more from being Blemiſhes in the Univerſe, that it may be doubted whether either the Animals or Vegetables of the Earth, could long ſubſiſt without them.

10. IT is commonly ſuppoſed, that the fixt Stars are ſo many Suns, ſhining with their own Light; and that each of them has a ſet of Planets moving round it, as the Earth and the other Planets do round our Sun. It may be ſo, or it may not; for we know nothing about them: Nor is it poſſible we ſhould know more. For even when viewed with the beſt Teleſcopes, they appear no larger than they do to the naked Eye. They are divided, according to their Size, into Stars of the Firſt, Second, and ſo on to the Sixth Magnitude.

EVEN a good Eye ſeldom ſees more than an hundred Stars at a time in the cleareſt Heaven. The Appearance of vaſt numbers in Winter Nights, is a mere Deception of our Sight, occaſioned by our viewing them confuſedly, not in any regular Order.

YET are they really almoſt infinite. For a good Teleſcope directed to almoſt any Part of the Heavens, diſcovers numbers unſeen by the naked Eye, particularly in the *Milky Way*: Which is indeed nothing elſe but an

Aſſemblage of Stars, too remote to be ſeen ſingly, but ſo cloſe to each other as to give that Brightneſs to ſo large a Part of the Heavens.

An hundred and twenty-five Years before Chriſt, *Hipparchus* diſcovered a New Star. In 1572 *Tycho Brahe* obſerved another. Its Magnitude at firſt exceeded the biggeſt of our Stars. It equalled that of Venus when neareſt the Earth, and was ſeen in fair Day light. It continued ſixteen Months, toward the End of which it grew leſs till it totally diſappeared. We have an account of One appearing at leaſt thrice before, at the Interval of 150 years. Probably it was the ſame Star, and will return at the ſtated time.

Many other New Stars have been obſerved in this Century to appear and diſappear; and it is certain from the old Catalogues, that many of the antient Stars are not now viſible.

There are now wanting two Stars of the Second Magnitude in the Ship *Argo* which were ſeen till the Year 1664. But there was not the leaſt Sign of them in 1668. Accurate Aſtronomers have obſerved many more ſuch Changes in the fixt Stars, to the number of an hundred.

Are theſe Temporary Stars a ſort of Planets? Are they fixt Stars, which being covered with Spots, like thoſe obſerved on the Sun, loſe their Brightneſs, and conſequently diſappear? Or are they Comets, which take ſo vaſt a time to perform their Revolutions, as ſeldom to have their Returns perceived?

II. It remains only, to make ſome Improvement of what has been obſerved, concerning the Syſtem of the Univerſe. And 1. we may obſerve the due *Situation* of the Heavenly Bodies. Firſt, None of them interfere with each other. Had the Univerſe been the Work of any but the wiſe Architect, there would have been many Inconveniences in the Situation of ſuch a prodigious Number of immenſe Globes. Some would have been too near, or too far off: Some would have incommoded others. But inſtead of this, all the Globes which fall under our notice, are ſet at ſuch a due diſtance, as not only to avoid all violent Concourſe, but not to ſhade each other, ſo as to hinder each other's kindly Influence, or to occaſion noxious ones. Secondly, As it is one great Inſtance of the Skill of an Architect, to give due *Proportion* to his Works, ſo this abundantly appears in all the Heavenly Bodies that come under our cognizance. Curious Order, and due and nice Proportions are obſerved in their Situations. The Sun is placed in the Center of his Syſtem, to give all his Planets Heat and Light. Then follow the ſeveral Planets ſurrounding him, not ſcattered at all adventures, but at due Diſtances from the Sun, as well as from one another. And this is diſcernible, not only in the Primary, but the Secondary Planets too: In the five Moons that attend Saturn, and the four that accompany Jupiter.

THE Wiſdom of the Creator appears, ſecondly, from the *Motions* of the Heavens and Earth. That theſe vaſt Globes ſhould move at all, proves ſome Being that has Power to put them in motion: Seeing Matter cannot move itſelf. And ſuppoſe them moved by the Sun, the Ether, or ſome other primary Mover, ſtill we muſt recur to ſome Firſt Cauſe who was able to put the Mover into motion. And this could be no other than the Hand of the Almighty. What farther ſhews both his Power and Wiſdom, is that thoſe Motions are not at random, or in inconvenient Lines and Orbs, but ſuch as manifeſt the deepeſt Counſel. That every Planet ſhould have as many and various Motions, as the World and its Inhabitants have occaſion for, muſt be the Work of a wiſe and kind, as well as omnipotent Creator.

IN particular, the *Diurnal* Motion of theſe Globes ſhews the Wiſdom of the Creator. Of what prodigious Uſe is this! Were the Planets always to ſtand ſtill, Half of each Globe would be dazled and parched with unceaſing Day, and the other half wrapt in everlaſting Darkneſs. Were this the Caſe with our Globe, a great Part of it at leaſt would ſcarce be habitable. It would neither agree with the State of Man or other Animals, nor of Vegetables. How could the Vapours be raiſed, to ſupply the Earth with cooling Clouds and fruitful Showers? How could the Winds be excited to fan the Atmoſphere with their pleaſant and healthful Gales? How could Vegetables be raiſed up by the kindly Heat of the Day, and tempered by the Dews and Cool of the Night? How could Men and other Animals gather their Food, and perform the various Labours of the Day, and then under the ſalutary Influences of the Night, recruit themſelves with Reſt and Sleep?

AND as the Diurnal, ſo the *Annual* Motion of the Heavenly Bodies, is a clear Manifeſtation of the Creator's Wiſdom: Eſpecially when we conſider the different Paths of their Diurnal and Annual Motions. Theſe lie not in a very different Plane, nor in the ſame, but a little croſſing one another: The Diurnal, lying in, or parallel to the Equator, the Annual, at an Inclination of twenty-three Degrees and an half. A glorious Contrivance this for the Good of our Globe, and for all the reſt that have the ſame Annual Motion. For were the Earth's Annual Motion to be always in the ſame Plane with the Diurnal, we might indeed be ſometimes nearer to the Sun than we now are. But we ſhould miſs of thoſe kindly Increaſes of Day and Night, which the Approach of Earth to one or the other Pole occaſions. This is likewiſe the great Cauſe of Summer and Winter. Indeed one Cauſe of them is, the longer or ſhorter Continuance of the Sun above the Horizon. As it continues longer in Summer, it increaſes the Heat, as much as it lengthens the Day: And juſt the contrary in Winter. But the chief Cauſe is, the Oblique or Perpendicular Direction of the Sun's Rays. For 1. Perpendicular Rays ſtrike on any Plane, with greater force than Oblique. And 2. A greater Number of Rays fall within the ſame Compaſs, in a perpendicular than in an oblique Direction.

A farther Manifeſtation of the Creator's Wiſdom we have in the *Perpetuity*, *Conſtancy* and *Regularity* of thoſe Motions. How without an Almighty Guide ſhould thoſe vaſt Bodies continue their Courſes throughout all Ages? How ſhould they perform their uſeful Stages, without the leaſt Intermiſſion or Diſorder? What piece of Clock-work under heaven, was ever comparable to this? How ſteddily do all theſe Motions conſpire, to anſwer the Ends of Divine Providence, to diſpatch the noble Offices of the ſeveral Globes, to comfort and cheriſh every thing reſiding on them, by the uſeful Change of Day and Night, and the ſeveral Seaſons of the Year?

We may learn the Wiſdom of God, Thirdly, from the *Figure* of the Heavenly Bodies, ſo well ſuited to the Motions and to the whole State and Convenience of them. And 1. They are all nearly Spherical: I ſay, nearly, to allow for the Difference between their Polar and Equatorial Diameter. Now this Figure is both more capacious than any other, and more agreeable to a Maſs in Motion, each Part of it being at a due diſtance, from the Center of Motion and Gravity: Beſides, without this, there could have been no ſuch agreeable Alterations of Day and Night, of Heat and Cold. And as to our own Globe, the Winds could not have fanned the Air, as now, but muſt have been greatly retarded, if not wholly ſtopt, by the Angles and Jettings out of other Figures. Laſtly the Waters would have had intolerable Confluences; here too much, there none at all. So that inſtead of an habitable World, far the greateſt Part would have been a Deſert, or an uſeleſs Bed of Waters.

And all the Parts of the Earth are ſo diſtributed, as may beſt miniſter to their ſeveral Uſes. Thus the two grand Parts, the Solids and Fluids, inſtead of being jumbled into one maſs, are admirably parted, and as nicely diſpoſed of in proper Places. The Strata conveying ſweet Water, are in all or moſt parts of the world, conſiſt of proper, pervious Matter, remain diſtinct from the other Strata, and lie at ſuch due Depths, as either to break out in Fountains, or to be dug into, for Wells: All which is a manifeſt Demonſtration of the Concern of a wiſe Agent.

And not only the Planets are a Demonſtration of this, but the very *Comets* alſo: Tho' their Motions are ſo far from being always the ſame way, that they move ſometimes contrary to each other. Their Planes and Directions lie every way, and their Orbits are exceeding eccentrical. But this very Eccentricity is an admirable Contrivance of the Creator, to prevent their diſturbing either the Planets, or one another, by mutual Attractions. By this means they have ſufficient room to revolve in: And by aſcending to very great Heights, and ſpending almoſt all their time in the remote Regions of the Univerſe, at vaſt Diſtances both from the Planets and each other, they incommode neither. Whereas had they moved in the ſame Plane with the Planets, they would ſometimes have come too near them; and poſſibly have diſturbed *their* Motions, or even daſhed againſt them.

BUT what would all the Planets have done, had they not been ſupplied with Light and Heat? And what an indulgent Proviſion of theſe is made, even for the moſt diſtant of them? See the Sun, ſuch a prodigious Maſs of Fire, placed in the Center of the Syſtem, to ſcatter his Light throughout the whole, and to warm and cheriſh us by Day: And ſuch a noble Retinue of Moons and Stars, attending and aſſiſting us by Night! And we ſee the ſame Care of the Creator, extended to all the other Planets. According to their ſeveral Diſtances, they have proportionably a greater number of Moons, and Saturn a ſtupendous Ring beſides, to ſupply the Decreaſe of Light and Heat. Who can help being amazed at ſuch well-contrived, ſuch ſtately Works of GOD? Who can partake of their beneficial Influences, and not adore the Wiſdom and Kindneſs of their Maker?

ONE or two Points, which have been lightly mentioned already, deſerve a more particular Conſideration.

THAT He who diſpenſes Exiſtence at his Will, ſhould multiply, extend, inlarge, and add a kind of Immenſity to his Works, is not properly what ſurprizes me; at leaſt my Amazement is chiefly founded on my own extreme Littleneſs. But what aſtoniſhes me moſt, is to ſee that notwithſtanding this my extreme Littleneſs, he has vouchſafed to regulate his immenſe Works, by the Advantages I was to receive from them! Thus he has placed the Sun juſt at ſuch a Diſtance from the Earth on which I was lodged, that it might be near enough to warm me, yet not ſo near, as to ſet it on fire.

THE Rays that proceed from a Globe of Fire, many thouſands times bigger than the Earth, muſt needs have an inconceivable Force, while they remain cloſe to each other. But they are more and more diſtant from each other, as they advance from their common Center, toward the vaſt Circumference they are to inlighten, and their force diminiſhes in proportion. Had the Earth been placed, where theſe Rays were ſtill too numerous, and too near each other, it could never have borne their burning Heat. Had it been placed farther off than it is, it would have received but a faint Warmth, ſuch as was inſufficient for its uſual Productions. It ſtands in that very place where it is ſecured from all theſe Inconveniences, and within the reach of every Advantage.

The Heavens declare the Grandeur and Glory of God, from one end of the World to the other. But the Sun alone affects us more than all the Beauties the Heavens can diſplay to our ſight. The Heavens are only a Pavilion to the Sun. The richly-embroidered Veil which ſeemed to hide him from us for a ſeaſon, is removed when he advances. At firſt, he appears as a young Bridegroom, coming out of his Chamber. His Splendor is then full of Mildneſs, and he is eaſy of acceſs. But he is commiſſioned to convey the Heat and the Life, as well as the Light, every where. He darts more and more Fire as he aſcends. He paſſes from one End of the Heavens to the other. There is nothing that can either be hid from his Light, or ſubſiſt without his Heat. And by his penetrating fires he reaches thoſe very places, which are inacceſſible to his Rays.

And yet we need his Abſence at proper Intervals, no leſs than we do his Preſence. For *Night* and Sleep are ſo connected, that when we want Repoſe, we generally procure a kind of artificial Night. Our Senſes are ſeldom unbent, but by the Removal of that which agitates them. And this is the Service for which Night is appointed, and which it excellently well performs. It does not come in a blunt and abrupt manner, to extinguiſh the Light of the Day, and all on a ſudden to rob us of the Sight of the Objects we are intent on; but advances only by ſlow ſteps, and brings on Darkneſs by degrees. 'Tis not 'till after reminding us of the Neceſſity of taking reſt, that it covers the face of Nature.

During the time of Man's Repoſe, Night huſhes every Noiſe. It indeed ſuffers a few Animals, whoſe grim Aſpect might ſcare him, to go forth and ſilently ſeek their Food. It permits however the Animal that ſtands Centinel by him, to give him notice of what concerns him. But it keeps the Horſe, the Ox, and all his Domeſtics faſt aſleep around him. It diſperſes the Birds, and ſends each to his reſpective Abode. As it comes on, it gradually huſhes the Winds, to ſecure the Lord of Nature's Reſt. It cauſes his Repoſe to be reverenced every where; the moment of which is no ſooner come, but all Creatures retire, and for ſeveral Hours an univerſal Silence reigns.

Nor yet is Nature's Palace wholly void of Light. As ſome may be conſtrained to travel by Night, ſeveral Flambeaux are ſcattered thro' the Firmament. But theſe tho' they prevent total Darkneſs, yield only a gentle Light. Nor ought thoſe who then wake to be ſupplied with ſuch a Light, as would interrupt the Repoſe of others.

But it is not by its Darkneſs only, that Night is uſefull to us. Its Coolneſs likewiſe is of uſe: And this increaſing the Spring of the Air, makes it capable of working with greater Activity, and giving new Vigour both to the dry Plants and the enfeebled Animals. It is to preſerve this Cool, that the Moon reflecting the Light of the Sun, gives it without any ſenſible Heat. In vain do we collect her Rays by the ſtrongeſt Burning-glaſs. An admirable Caution of the Divine Artificer, who has reſerved for the Night ſeaſon, a light ſtrong enough to remove Darkneſs, yet too weak to alter the Coolneſs of the Air.

When Man is inclined to have the Benefit of this, he ſees no more the Proſpects of the Day; but Night, in her turn, favours him with another, that has Charms to itſelf.

We cannot doubt but theſe immenſe Globes of Fire, which enlighten our Night, have all their peculiar Appointments, which anſwers, in God's Purpoſes, the Magnificence of their Appearance. But who ſhall preſume to explain, what the Almighty has thought fit to conceal? The ſmall Glimpſes which a few are permitted to have, being quite unknown to the bulk of Mankind: It is not in the particular Deſtination of each Star, nor in the general Harmony of all, that we are to look for the means of inſtructing Man, or regulating his Affections. But yet what we do ſee, and know concerning them, is matter for the deepeſt Admiration. We ſee innumerable Fires hung up in the magnificent Cieling of our Abode: And the dark Azure which ſerves them as a Ground, ſtill heightens their Beauty and Brightneſs. But their Rays are diſperſed thro' Spaces ſo immenſe, that when they come to us, they are quite deſtitute of Heat. Thus by the Creator's Providence we enjoy the Sight of a multitude of fiery Globes, without any Danger of deſtroying the Coolneſs of our Night, or the Quiet of our Repoſe.

The Sum of what has been ſaid, with ſome farther Improvement, I add in the Words of Mr. *Hervey*.

The Earth is, in fact, a round Body, tho' in ſome Parts raiſed into Hills, or ſunk into Valleys, in others ſpread out into wide and immeaſurable Plains. For the loftieſt Mountains bear no more proportion to the whole Surface of the Ball, than a particle of Duſt on the Aſtronomers Globe, bears to its whole Circumference. We may fancy, that it has deep Foundations, and reſts on ſome ſolid Baſis. But it is pendent in the wide tranſparent Ether, without any viſible Support either from above or beneath. It may ſeem to remain ſtill and motionleſs: But it is continually *ſailing* thro' the Depths of the Sky, and in the Space of twelve Months, finiſhes the mighty Voyage. This Periodical Rotation produces the Seaſons, and completes the Year. And all the time it proceeds in its annual Circle, it *ſpins* upon its own Center, and turns its ſides alternately, to the great Fountain of Light. By this means the Day dawns in one Hemiſphere, while the Night ſucceeds in the other. Without this Expedient, one Part of its Regions, would during half the great Revolution, be ſcorched with exceſſive Heat and languiſh under an uninterrupted Glare: While the other would be frozen to Ice, and buried under diſmal and deſtructive Darkneſs.

The Earth in the Revolution which it performs daily on its own Axis, *whirls about* at the rate of above a thouſand Miles an Hour. What an amazing Force muſt be requiſite, to protrude ſo vaſt a Globe, and wheel it on, loaded with huge Rocks and Mountains, with ſuch a prodigious Degree of Rapidity!

Meantime the Sun, which ſeems to perform its daily Stages, is *fixt* and *immovable*. 'Tis the great Axle of Heaven, about which the Earth and many larger Orbs wheel their ſtated Courſes. And ſmall as it ſeems, 'tis far larger than the Earth: Sir *Iſaac Newton* ſuppoſes, 900,000 times. Are we ready to cry out, How mighty is the Being, who kindled ſuch a prodigious Fire? And keeps alive from Age to Age, ſuch an enormous Maſs of Flame? And yet this Sun, with all its attendant Planets, are but a very ſmall Part of that grand Machine, the Univerſe. Every Star is really a vaſt Globe, like the Sun in ſize and in Glory. Nay every Star, as ſome ſuppoſe, is not barely a World, but the Center of a magnificent Syſtem; has a Retinue of Worlds, enlightened by its Beams, and revolving round its Orb: All which are loſt to our ſight, in immeaſurable Wilds of Ether.[t]

But could you ſoar farther yet, could you wing your way to the higheſt apparent Star, you would there ſee other Skies expanded, another Sun diſtributing his Beams by day, with other Stars, that gild the horrors of the alternate Night: And other, perhaps nobler Syſtems eſtabliſhed, thro' the boundleſs Dimenſions of Space. Nor does the Dominion of the great Sovereign, terminate even here. Even at the end of this vaſt Tour, you would find yourſelf advanced no farther than the *Suburbs* of Creation: Arrived only at the *Frontiers* of the great Jehovah's Kingdom.

Think on this. When innumerable Bodies, many of them more than an hundred thouſand miles in Diameter, are ſet in *motion*: When the *Orbits* in which they move are extended, to Hundreds of Millions of miles:

When

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[t] All this is ſpoken, on the *Newtonian* Hypotheſis.

When each has a *diſtinct* and *ſeparate* Sphere, for finiſhing his vaſt Circuit: When none is *cramped*, but each *freely expatiates* in his unbounded Carrier: When every one is ſo immenſely diſtant from the others that they appear each to other as only ſo many Spots of Light: How aſtoniſhing is the Expanſe which yields room for them all, and their widely diffuſed Operations! To what Lengths did the Almighty Builder ſtretch his Line, when he marked out the ſtupendous Plat-form! I wonder at ſuch an immeaſurable Extent: My thoughts are loſt in this Abyſs of Space.

To go one ſtep farther ſtill: When I contemplate thoſe ample and amazing Structures, erected in endleſs Magnificence, over all the ethereal Plains: When I look on them as ſo many Repoſitories of Light, or fruitful Abodes of Life: When I remember there are Orbs vaſtly more remote, than thoſe which appear to our unaided Sight: When I ſtretch my thoughts to the innumerable Orders of Beings, which inhabit all thoſe ſpacious Syſtems, from the higheſt Seraph to the puny Nations that tinge the Plum with blue, or mantle the ſtanding Pool with green, How various are the Links in this immenſe Chain, the Gradations in this univerſal Scale of Exiſtence! Yet all theſe are the Work of God's Hand, and are full of his Preſence!

He rounded in his Palm thoſe dreadfully large Globes, which are pendulous in the Vault of Heaven. He kindled thoſe aſtoniſhingly bright Fires, which fill the Firmament with a Flood of Glory. By Him they are ſuſpended in fluid Ether, and never can be ſhaken: By Him they diſpenſe a perpetual Tide of Beams and never are exhauſted. He formed that exquiſitely fine Collection of Tubes, that unknown Multiplicity of ſubtle Springs, which organize and actuate the Frame of the minuteſt Inſect. He bids the crimſon Current roll, the vital Movements play, and joins together a World

Wonders, even in an *animated Point*. For there are living Creatures abundantly ſmaller than a Mite. Mr. *Bradley* mentions ſome, which by computation he found to be a thouſand times leſs, than the leaſt *viſible* Grain of Sand: At the ſame time he declares, That this was a bulky Being, compared to others diſcovered by Mr. *Lewenhoeck*. If then we conſider the *ſeveral Limbs*, which compoſe ſuch an organized Particle; the different *Springs* which actuate thoſe Limbs; the Flow of *Spirits* which put thoſe Springs in motion; the various *Fluids* which circulate; the different *Secretions* which muſt neceſſarily be performed; together with the proportionable Minuteneſs of the Solids, before they arrive at their full Growth: We ſhall ſee the utmoſt Reaſon to own, that the Creator is greatly glorious even in his ſmalleſt Works.

To conclude this Head. If the Stars are Magazines of *Fire*, and immenſe Reſervoirs of *Light*, undoubtedly they have ſome grand Uſes, ſuited to the Magnificence of their Nature. To determine what Uſes, is not poſſible, in our preſent State of Diſtance and Ignorance. This however is clear, they are diſpoſed in ſuch a manner, as is moſt pleaſing and ſerviceable to Mankind. They are not placed at ſuch an infinite Remove, as to lie beyond our Sight: Neither are they brought ſo near to our Abode, as to annoy us with their Beams.

CHAP. III.

Of the Properties that are common to all Bodies, and of the Elements of Natural Bodies.

1. *Of Extenſion:*
2. *Of a Vacuum:*
3. *Of Solidity:*
4. *Of Diviſibility:*
5. *Of Motion and Reſt:*
6. *Of the Laws of Motion:*
7. *Of the Ariſtotelic Elements:*
8. *Of the Principles of the Chymiſts:*
9. *Objections to them:*
10. *What is the Primary Element of all things.*

1. HAVING ſpoken of the particular Species of Bodies, it remains only to ſpeak of Bodies in general. And it may be obſerved of them all, that they are extended, ſolid, diviſible, figured and capable of Motion. We cannot conceive any Body that is not *extended*, or compoſed of ſeveral Parts. And yet we cannot affirm, that the *Eſſence* of Body conſiſts in this alone.

2. For there may be Extenſion without Body, which is uſually termed *Space* or a *Vacuum*. Theſe are widely different from each other. Body is diviſible and ſeparable into Parts, and conſequently capable of Motion; none of which can be ſaid of mere Space. And that there is Empty Space is clear from hence. That if all were full, there could be no Motion in the world. For in order to this it is requiſite that each Particle leave its place empty for another to fill. It is ſaid indeed, this need not be, becauſe all Motion is circular, ſo that in every motion of whatever kind, each Part of the Body moved ſucceeds another. But this is abſolutely contrary to matter of fact. We ſee with our Eyes, that all Motion is not circular. And if not, then there muſt be empty Space, or there could be no Motion at all.

3. ANOTHER Property of Body is *Solidity*, whereby it reſiſts another Body moving it out of its place. Not much different from this is *Impenetrability*, whereby a Body excludes another from the place where it is. Solidity is not the ſame with *Hardneſs*, the former belonging to All, the latter to ſome Bodies only. Hardneſs conſiſts in the firm Coheſion of the Parts, ſo as not eaſily to be ſeparated. As the Solidity of Bodies flows from the intrinſic Nature of Matter it is vain to aſſign as the Cauſe of it, either the Figure or Reſt of the Parts, or the Preſſure of the Air, or of ſome ſubtle Matter. By theſe Solutions we do not at all explain the thing, but only intangle ourſelves in freſh Difficulties.

4. *Diviſibility* likewiſe belongs to all Bodies. For ſince no Body can be conceived that is not extended, and Extenſion ſuppoſes Parts, it follows that every Body, however ſmall, is diviſible: Perhaps not by the Art of Man, but in its own Nature. Nor is it any Objection, that our Underſtanding cannot comprehend *infinite Diviſibility*. It cannot: nor can it comprehend infinite Number: Or indeed Infinites of any kind.

IT is true, there is no ſuch thing, ſtrictly ſpeaking, as Parts infinitely ſmall. Yet the Smallneſs of the Particles of ſeveral Bodies, is ſuch as vaſtly ſurpaſſes our Conception. And there are innumerable Inſtances in nature of ſuch Parts actually ſeparated from each other.

MR. *Boyle* gives us ſeveral Inſtances of this. He ſpeaks of a ſilken Thread 300 Yards long, that weighed but two Grains and an half. Fifty Square Inches of Leaf-Gold weighed but One Grain. Now if the length of an inch be divided into 200 Parts, the Eye may diſtinguiſh them all. Therefore there are in one ſquare Inch, forty thouſand viſible Parts, and in one Grain of Leaf-Gold, two Millions of ſuch Parts: Which viſible Parts no one will deny to be farther diviſible. In odoriferous Bodies we may diſcern a ſtill greater Subtlety of Parts, yea of parts actually ſeparated from each other. Several Bodies ſcarce loſe any thing of their Weight in a long time, and yet continually fill a large Space with odoriferous Particles. Several Animals are but juſt viſible with the fineſt Microſcope. And yet theſe have all the Parts neceſſary for Life, as Blood and other Juices. How wonderful muſt the Subtlety of the Parts be, whereof thoſe Fluids are compoſed. And hence the following ſtrange Theorem is deduced and demonſtrated by Dr. *Keil.* "Any Particle of Matter, how ſmall ſoever, and any finite Space how large ſoever, being given, it is poſſible for that Particle to be diffuſed thro' all that Space, and to fill it in ſuch a manner, that there ſhall be no Pore in it whoſe Diameter ſhall exceed any given Line."

5. THE laſt General Property of Matter is *Motion* and *Reſt*. For 'tis plain, all Matter is either at reſt or in motion. GOD is the Firſt and Univerſal Cauſe of Motion, as well as of all things. The immediate Cauſe of it, is either Matter or Spirit. It is beyond doubt, that a Body moved communicates its Motion to another, tho' in its own Nature it be purely paſſive. Nor can we reaſonably deny, that a Spirit is able to move Matter, altho' the Manner of its doing this we cannot comprehend.

6. ALL the Laws of Motion may be reduced to Three. 1. Every moving Body is moved by another: 2. Every moving Body communicates its Motion to any Body it meets: 3. Every moving Body continues in motion, 'till it communicates that motion to another. While theſe Laws remain in force and concur in producing various Effects, thoſe Effects are termed Natural. When any of theſe Laws is ſuſpended, this is properly a Miracle.

7. As the Elements or firſt Stamina of Bodies are too ſmall to be diſcerned by any of our Senſes, we can only form Conjectures concerning them. The moſt probable Conjectures are theſe. *Empedocles*, and *Ariſtotle* from him ſuppoſed, there are four Elements, *Fire*, *Air*, *Water* and *Earth*. And indeed this Diviſion ſeems to be grounded on the Nature of things: For there is no doubt but at the Creation of this Globe, the confuſed Maſs was ſeparated into four Parts, the heavieſt of which conſtituted the *Earth*, the Particles next in weight the *Water*, the third, lighter ſtill, *Air*, and the lighteſt of all, *Fire*, otherwiſe termed *Ether*. And it is manifeſt, all Bodies known to us, are reducible to one or more of

theſe. Every thing corporeal is either Earth, Air, Water or Fire, or compounded of them. So that after all the Diſquiſitions of two or three thouſand Years, this eaſy, plain, natural Account of the Elements, is not likely to be amended; it being a certain Fact, that of theſe do all Bodies conſiſt.

8. The *Chymiſts* have taken another way endeavouring to trace the Principles of Bodies, not by the ordinary uſe of their Senſes, nor by Reaſoning, but from Experiments made by Fire. And by this means they make five Elements. For whatever is diſtilled, firſt emits a ſapid and ſpirituous Vapour, which is by Cold condenſed into a Liquor: And this they term *Mercury:* Then an inſipid Liquor, which they call *Phlegm:* Afterward an acid Liquor, which is alſo termed *Mercury*. A thicker and oily Liquor comes next, which becauſe eaſily inflammable is ſtiled *Sulphur*. The *Salt* which is afterwards found is their fourth Element, the inſipid *Earth*, which is left, the Fifth.

9. But not to inſiſt, That all Bodies are not reſolvible into theſe Principles, it is utterly uncertain, Whether Fire does not alter the Natural Qualities of Bodies, and introduce other Qualities into them, which they had not before. Beſides ſome of theſe are not ſimple Elements. They are compounded of others, Oils and Salts in particular. Therefore neither are all thoſe Oils and Salts of one ſort, but as various as the Bodies from which they are extracted. In truth, theſe are at moſt the conſtituent Parts of two of the *Ariſtotelic* Elements, namely Water and Earth: But the two others, Air and Fire, are quite omitted in their account.

10. Perhaps one might rather term *Matter* itſelf with its General Properties, the firſt and moſt ſimple Element, out of which all things are compounded. But the Particles of this are not fit to compoſe the immediate Stamina of larger Bodies, 'till they combine together into Oils, Salts and Juices of various kinds. And hence ariſe thoſe Principles of the Chymiſts, of which moſt Bodies are compounded: Altho' ſtill they are only Secondary Elements, as being themſelves compounded: And ſo are at leaſt Two of the *Ariſtotelic* Elements,

namely Water and Earth. For theſe Elements alſo may be reſolved into others more pure and ſimple. Indeed it ſeems probable, God in the beginning, formed Matter in ſolid, impenetrable, moveable Particles, of ſuch Sizes and Figures as moſt conduced to the End for which he formed them ; and that theſe Primitive Bodies are incomparably harder than any porous Bodies compounded of them : Even ſo hard as never to wear out, no natural Power being able to divide them. And thus remaining entire, they compoſe Bodies of the ſame Nature and Texture in all Ages : Whereas ſhould theſe wear away, or break in pieces, the Nature of things depending on them would be changed. Nor would Water and Earth, compoſed of broken, worn-out Particles, be the ſame as they were at the beginning. But they are the ſame in all Ages : And the Changes of things do not imply any Change in thoſe original Particles, but only various Aſſociations and Separations of them. Nor do compound Bodies ever break in the middle of ſolid Particles, but where thoſe Particles are joined together, and only touch in a few Points.

CHAP IV.

Of thoſe things wherein Natural Bodies differ.

1. *Of the particular Properties of Bodies :*
2. *Of Light :*
3. *Of Colours :*
4. *Of Sounds :*
5. *Of Smells :*
6. *Of Taſts :*
7. *Of Moiſture and Dryneſs ; Heat and Cold :*
8. *Of Gravity :*
9. *Of the other Properties of Bodies :*
10. *Of Occult Qualities :*
11. *Reflections.*

1. HAVING conſidered wherein Natural Bodies agree, we come now to conſider, the particular Properties wherein they diſagree, and whereby they

are diſtinguiſhed from each other. Thoſe of them which are perceived by our outward Senſes, are divided accordingly into various Claſſes, as they affect the Senſe of Sight, of Hearing, of Taſte, of Smelling, or of Feeling.

1. *Light* ſeems to be one of the moſt ſubtle Bodies in the Univerſe. The grand Reſervoir thereof is the Sun: But it is likewiſe emitted by many other Bodies, and by almoſt all, when they are on fire. When it falls on any Body which it cannot paſs thro', and ſo is beat back, it is ſaid to be *reflected*. But when it paſſes from one *tranſparent* Body into another, which is either rarer or denſer, it moves obliquely, its Rays being bent, and is ſaid to be *refracted*. When it paſſes thro' a Body in ſtreight lines, it is ſaid to be *tranſmitted*. Thoſe which emit the Light are termed *lucid* Bodies; thoſe which reflect it, *opake*.

THE Particles of Light, minute as they are, are attracted by thoſe of other Bodies. Hence in their Paſſage near the Edges of Bodies, whether opake or tranſparent, they are diverted from the right Lines, and reflected toward thoſe Bodies. This Action of Bodies on Light exerts itſelf at ſome Diſtance, but increaſes as the Diſtance is diminiſhed: As appears in the paſſage of a Ray between the Edges of two thin Planes, at different Apertures; in which it is peculiar, that the Attraction of one Edge is increaſed, as the other is brought nearer it. The Rays of Light paſſing out of Glaſs into a Vacuum, are not only inflected toward the Glaſs, but if they fall too obliquely, they will revert back to the Glaſs, and be totally reflected. This Reflection cannot be owing to any Reſiſtence of the Vacuum, but merely to the attracting Power of the Glaſs. This appears farther from hence: If you wet the poſterior Surface of the Glaſs, the Rays, which would otherwiſe have been reflected, will paſs into and thro' that Liquor; which ſhews that the Rays are not reflected, 'till they come to the poſterior Surface of the Glaſs; nor even till they begin to go out of it. For if at their going out, they fall into any Liquor, they are not reflected, but perſiſt in their Courſe, the Attraction of the liquor counterbalancing that of the Glaſs.

From this mutual Attraction between the Particles of Light and other Bodies, ariſes the Reflection and Refraction of Light. The Determination of any moving Body is changed, by the interpoſal of another Body. Thus Light meeting any ſolid Body, is turned out of its way and reflected: But with this peculiar Circumſtance. It is not reflected from the Body itſelf, but by ſomething diffuſed over the Surface of that Body, before it touches it. It is the ſame thing in Refraction. The Rays refracted come very near the refracting Body; yet do not touch [u] it. Thoſe that actually touch ſolid Bodies, adhere to them, and are as it were extinguiſhed and loſt.

Again. Rays paſſing from a more rare into a more denſe Medium, are turned out of their Right Line, becauſe more ſtrongly attracted by the denſer Medium.

Rays of Light differ in reſpect of Refraction, Reflection and Colour. Thoſe that agree in the firſt of theſe, agree in all, and may therefore be termed *Homogeneal.* Colours exhibited by Them we may call *Homogeneal Colours.* This being premiſed, we may obſerve, 1. That the Sun's Light conſiſts of Rays variouſly refrangible: 2.

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[u] This entirely agrees with the curious Obſervation of an inge-Writer. "It is common to admire the Luſtre of the Drops of Rain, that lie on the Leaves of Coleworts and ſome other Vegetables. Upon inſpecting them narrowly, I find the Luſtre riſes from a copious Reflection of the Light, from the flattened Parts of its Surface, contiguous to the Plant. When the Drop rolls along a Part which has been wetted, it immediately loſes all its Luſtre. The green Plant being then ſeen clearly thro' it, whereas in the other Caſe it is hardly to be diſcerned.

From theſe two Obſervations laid together, we may conclude the Drop, when it has the Luſtre does not really touch the Plant, but hangs in the Air at ſome diſtance from it, by the force of a repulſive Power. For there could not be ſo copious a Reflection of Light from its under Surface, unleſs there were a real Interval, between it and the Surface of the Plant.

Now if that Surface were perfectly ſmooth, the under Surface of the Drop would be ſo likewiſe, and would therefore reflect the Image of the illuminating Body, like a piece of poliſhed Silver. But as it is rough, the under Surface of the Drop becomes rough likewiſe; and ſo reflecting the Light copiouſly in different Directions, aſſumes the Colour of unpoliſhed Silver.

2. That Rays variouſly refrangible, when ſeparated from each other, exhibit different Colours: 3. That there are as many ſimple, homogeneal Colours, as there are Degrees of Refrangibility: 4. A Compoſition of all the ſimple Colours, is requiſite to conſtitute Whiteneſs: 5. The Rays of Light do not act upon one another, in paſſing thro' the ſame Medium: 6. Neither do they thereby ſuffer any Refraction: 7. The Sun's Rays contain all Homogeneal Colours, which may therefore be called *Primitive*.

As ſome Rays of Light are leſs than others, ſo they are more refrangible. Thoſe which are moſt refrangible conſtitute *Violet* colour: that is the ſmalleſt Rays excite the moſt languid Colour. Thoſe which are largeſt and ſo leaſt refrangible, conſtitute *Red*, the moſt vivid Colour. The other Rays excite intermediate Senſations, according to their reſpective Size and Refrangibility.

BODIES reflect, inſtead of tranſmitting Light, that is, are opake, not tranſparent, not for want of Pores; but either becauſe of the unequal Denſity of their Parts, or the Magnitude of their Pores. Either *your* Pores are empty, or they are filled with Matter of a different kind, whereby the Rays are variouſly refracted and reflected, till they are quite abſorbed.

HENCE Paper and Wood are opake, while Glaſs is tranſparent. For in the Confines of Parts alike in Denſity (ſuch as thoſe of Glaſs and Water) there ariſes no Refraction or Reflection, by reaſon of the equal Attraction every way, ſo that the Rays which enter the firſt Surface, paſs ſtrait thro' the Body. But in the Parts of Wood and Paper, which are unequal in Denſity, and contain much Air in their large Pores, the Refractions and Reflection are very great, ſo that the Rays cannot paſs thro' them, but are bandied about till they are extinguiſhed.

HENCE Opake Bodies become tranſparent, when their Pores are filled with a Subſtance of equal Denſity: As Paper dipt in Water or Oil. And on the contrary, tranſparent Bodies, by emptying their Pores, or ſeparating their Parts, become opake. Thus Salts and wet Paper become opake by Drying, Glaſs by pulverizing.

Yea, Water itſelf, if beat into Froth, loſes its tranſparency.

THAT Light is corporeal, cannot now be doubted, having been proved by a thouſand Experiments. By Reflection and Refraction it may be turned more or leſs out of its way, according to the different Denſities of the reflecting or refracting Medium. Its Rays in their progreſſive Motion may be intercepted, by the interpoſal of any opake Object. And when this is removed, they proceed again, in the ſame ſtrait Courſe as before. They may likewiſe be contracted into a leſs, or diffuſed thro' a larger Space, while the Quantity of Light continues the ſame, neither increaſed nor diminiſhed. So in the Focus of a Burning-glaſs, all the Rays which would otherwiſe paſs directly thro' the Glaſs, are contracted into one bright Spot, while the circumambient Space, for the breadth of the Glaſs, is deprived of its Light and left ſhaded. And the Action of Light thus condenſed, is proportional to its Quantity, and produces all the Effects of the moſt intenſe Fire, yea ſuch as no culinary Fire will produce. Whence it is plain, that Fire and Light are eſſentially the ſame, and that Fire is only condenſed Light.

THE Materiality of Light is farther confirmed by its Motion. For Viſion is propagated thro' this Medium ſucceſſively, as Sound is thro' Air. This has been demonſtrated from the Eclipſes of Jupiter's Satellits. For the Satellit having been hid behind the Planet, it requires a certain time, after it emerges, before its Light can reach the Eye, namely ſeven Minutes and an half: Which is a Motion ſix hundred thouſand times ſwifter than that of Sound thro' the Air.

THE Quantity of Elementary Light, is *cæteris paribus*, every where the ſame at the ſame Diſtance from the Sun. But its Action is more or leſs intenſe, as the Rays are more direct or oblique. Theſe are in a continual vibrating Motion, going and returning to and from the reſiſting Medium, in exceeding ſhort and imperceptible Intervals, which makes the Element ſeem to be at perfect reſt. All the Rays are refracted and reflected alternately ; ſo that the ſame incident Ray, which is refracted at one Interval, is reflected at the next. This is viſible in tranſparent Mediums, where the Rays fall upon Glaſs, Water and the like. But in opake Bodies, tho' the Fact is the ſame, it is not ſo ſenſible. When the Rays fall upon Glaſs, they are reflected one moment and tranſmitted the next. And this vibrating Motion ſeems to be eſſential to Light, when its Rays are put into motion.

In talking of Light and Sound, we are apt to confound the Senſation with the Motion of the Medium that excites it. Thus in a deep Calm we ſay There is no Air, becauſe we feel none ; tho' there is really the ſame Quantity of Air in equal Space, as if it blew a Storm. And ſo in deep Darkneſs we ſay, There is no Light in the room : Altho' there is really (ſtrange as it may ſound) as much Light there, as there was at Noon-day. Only its Rays are quieſcent, and make no impreſſion upon the viſive Organs. On the other hand, when a Candle is brought, we imagine a Flood of Light comes in : Whereas in fact, all that is done by the Candle is, to put the Light which was there before into motion.

Sound moves about fourteen Miles in a Minute ; which is performed thus. The Stroke given by the ſounding Body to the contiguous Air, is communicated to the next, and ſo on 'till it reaches the Ear. Light is propagated about two hundred thouſand miles in a Second, after the very ſame manner. The Sun impreſſes the contiguous Part of its viſive Atmoſphere : (Light ſeems to be the Atmoſphere of the Sun, as Air is, of all opake Bodies.) That Part impreſſes the next, and ſo on, 'till it reaches the Eye.

All Senſation is from Contact or Feeling. And when the Object is not in immediate Contact with the Organ, it affects, touches or impreſſes it, by an interpoſed Medium By this means the Soul perceives or feels the Object by the proper Organ. And thus Seeing is, in effect, the Feeling of the Eye, Hearing, the Feeling of the Ear.

From all our Experiments it appears, that the Particles of Light are extremely minute. Probably they are the very ſmalleſt and laſt Diviſions of Matter, which being perfectly ſolid, cannot receive any other Form. So minute are they as to paſs freely even thro' the Pores of Glaſs, which no other Fluid can penetrate.

ALL other Bodies are immerſed in this univerſal Fluid, the common Medium of all their Actions on each other. But amidſt all the Changes of Compound Bodies, all the Forms they ſucceſſively put on, this ſimple Element remains ever fixt and immutable.

As to Fire or condenſed Light, all Bodies whatever fly or recede from it, in proportion to its Denſity: And this ſeems to be its firſt and moſt eſſential Property, that no other Body can exiſt with it, or bear its immediate Action. So far as it prevails, it diſſolves the cloſeſt and ſtrongeſt Coheſion of Parts in all other Bodies, and reduces them into ſo extremely minute Particles, that they evaporate in Air. And herein is an eſſential Difference between this and all other Diſſolvents in nature, that the Subſtance diſſolved cannot unite with the Diſſolvent, without deſtroying its Action.

WHEN Salt diſſolves in Water, Iron in Aqua fortis, or Gold in Aqua-regia, the Subſtance diſſolved is equally diffuſed thro' the Diſſolvent, ſo as to incorporate with it. But none of the things diſſolved by Fire, can mix or incorporate with it. They all fly off in Vapour: Otherwiſe the Fire is preſently extinguiſhed.

ELEMENTARY Light then, the Rays of which when condenſed take the Name of Fire, is an Element of a peculiar kind, not ſubject to the mechanical Laws of other Bodies. Now if we ſuppoſe a material Fluid, void of Gravity, Preſſure, or any other mechanical Power, all gravitating Bodies will move thro' ſuch a Fluid, as freely as *in vacuo*.

ELEMENTARY Light is a material Fluid, void of Gravity, Preſſure or any other mechanical Power. When condenſed, it is pure, elementary Fire, which excludes all other Matter out of the ſame Space. Yet it lies in the Focus of a Burning-glaſs, perfectly ſtill and quieſcent. Tho' it is ſurrounded by the Air, which is a gravitating Fluid, preſſing equally every way, yet this immechanical Element is not at all affected by it, ſo as to riſe or fall in it, or in the leaſt alter its State, either of Reſt or Motion, which muſt neceſſarily happen, were it endued with Gravity, or the other Mechanical Properties found in other Bodies.

And that the Rays of Light, in their progreſſive Motion, do not preſs, reſiſt, attract, or at all diſturb each other, is evident from Fact, tho' they come from every point of Space, that can be within the optic Angle of the Eye. Thus two men ſtanding at a diſtance and looking at each other, ſee one another at the ſame inſtant, and that by means of Rays, which act in contrary Directions, without the leaſt Reſiſtance. And any number of other men, ſtanding in any Poſition, may ſee the ſame men in the ſame inſtant, by Rays which croſs each other without any interruption, in all poſſible Angles. But in Sounds which move thro' a gravitating, reſiſting Medium, the Caſe is quite different. For a multitude of Sounds, from different ſonorous Bodies, cannot be diſtinctly heard: Particularly, when they come to the Ear, in many different Directions. For the Undulations of the reſiſting Medium, mixing with and diſturbing each other, confuſe the Senſation, throwing all together indiſcriminately to the Ear. Thus when a multitude of People are all talking together, the Ear receives only a confuſed Hum or Murmur; whereas the Eye can perceive all or any one of them diſtinctly and without Confuſion.

Indeed nothing is more ſure, than that Gravity, Preſſure, Reſiſtance, and all thoſe Affections of Bodies which are termed their mechanical Powers, are not intrinſic or eſſential to them. For ſince Matter is purely paſſive, and can only act as it is acted upon, it follows, that the active Force or Energy, which we obſerve thro' the whole material Syſtem, muſt be the effect of ſome extrinſic, non-eſſential Cauſe. And ſuch a Cauſe is Light. But then the Actions of this can never be mechanically accounted for. How this immechanical Fluid acts upon other Bodies, and determines their mechanical Powers, we can no more explain than how the Soul acts upon the Body, or the Mind upon Matter. But we are ſure this is not done by Weight, Preſſure, Reſiſtance, or any mechanical Property whatever.

"But what are the *General Laws of Nature*"? They are plainly the Rules or Principles, by which the Governor and Director of all things, has determined to act. Accordingly what we call *Mechaniſm*, is indeed the free Agency and continued Energy of the Author and Director of Nature. All the neceſſary Motion of Bodies therefore, and all the Laws and Forces whereby it is communicated and preſerved, are the continued, regular Will, Choice and Agency of the Firſt Cauſe, and inceſſant Mover and Preſerver of the Univerſe.

By the Help of this admirable, this firſt made, becauſe moſt neceſſary Creature, Light, all the Animal World is enabled to go here and there, as their Occaſions call. We can with pleaſure behold the glorious Works of God: We can view the Glories of the Heavens, the Beauties of the flowry Fields, the gay Attire and exquiſite Garniture of many Creatures. We can with admiration ſee the Great Creator's wonderful Art in the Parts of Animals and Vegetables. In a word we can behold the Harmony of this lower World, and of the Globes above, and ſurvey his exquiſite Workmanſhip in every Creature.

It is a great inſtance of his Providence, that ſo neceſſary as Light is, it is not long in paſſing from place to place. How inconvenient would it be, were the Motion of it no ſwifter, than that of the ſwifteſt Bodies on Earth, ſuch as of a Bullet out of a great Gun, or even of Sound itſelf? Did it move at the rate of the Firſt, it would be above thirty-two years in coming from the Sun to us (according to the *common* Computation of the Sun's Diſtance) Above 17 Years at the rate of the Second Motion. The Inconvenience of this would be, its Energy would be greatly abated, its Rays would be leſs penetrant, and Darkneſs would be diſſipated with greater Difficulty, eſpecially by the fainter Light of our ſublunary luminous Bodies. But paſſing with that prodigious Swiftneſs, (from the Sun to Us in ſeven or eight Minutes) we receive with Security and Speed the kindly Effects of that noble and uſeful Creature.

ANOTHER thing worthy of conſideration is, the inconceivable Extenſion of Light. It is as unlimited as the Univerſe itſelf, as is manifeſt from our ſeeing ſome of the moſt diſtant Objects, the Heavenly Bodies, partly with the naked Eye, partly with the help of Inſtruments. And had we Inſtruments of power equal to the Extent of Light, the luminous Bodies in the utmoſt Parts of the Univerſe, would doubtleſs be viſible too. Hereby we have a Ken of thoſe many glorious Works of the infinite Creator, which we can improve to ſome of the nobleſt Sciences, and moſt excellent Uſes of our own Globe.

ONE Species of *Lucid* Bodies are termed *Phoſphori:* Of which ſome are Natural, others Artificial. Natural Phoſphori emit Light without any Art or Preparation. Such are Glow-worms, and ſeveral Sorts of ſhining Inſects. Such are rotten Wood; the Eyes, Blood, Scales, Fleſh and Feathers of ſome Animals. Diamonds likewiſe when rubbed emit Light, to one who has ſtayed ſome time in the Dark. But before the Diamond is brought into the Dark Room, it ſhould lie eight or ten Seconds in the Sun-ſhine. It will then ſhine in the dark twelve or thirteen Minutes; but its Light gradually weakens all the time.

BUT it is remarkable, that ſome Diamonds have this Property of imbibing the Sun's Rays, and ſhining in the dark, and others not, tho' there is no other diſcernible Difference between them. Nor is there any Rule of Judging, which Diamonds have this Property, and which have not. Their Brightneſs, their Purity, their Size, their Shape, contribute nothing to it.

SULPHUR and Sugar when pounded in the dark, will likewiſe emit Light; as will the Backs of Horſes or Cats, when rubbed with the hand, and Sea-water, yea and ſome Mineral Waters, briſkly agitated. But no natural Phoſphorus ſhines always: Or gives any Heat.

Artificial Phoſphorus is made chiefly from Human Urine. But it may be made from Blood, or Hair; or indeed from any Part of an Animal, which yields an Oily Diſtillation. It is at firſt of the conſiſtence of hard Wax; but diſſolves in all kinds of diſtilled Oil. With ſolid Phoſphorus one may write on Paper as with a Pencil, and the Letters will ſhine in the dark. A little piece of it rubbed between two Papers, takes fire preſently. It burns vehemently, and penetrates deeper into the fleſh than Common Fire. It never ſpoils, if kept in a Phial full of Water. Liquid Phoſphorus does not keep long. If the Face or Hands be ſmeared with this, they will ſhine in the dark, yet without any hurt to the Skin.

IF Phoſphorus be put into a long Phial, of which three Fourths are filled with Water, it will frequently ſend up Coruſcations, which will pierce thro' the Water, and expand themſelves with great Brightneſs, in the upper Part of the Phial.

IF we compare this with Lightning, we may obſerve, that as in this the Fire paſſes unaltered thro' the Water, ſo in that the Flaſhes, which come at Intervals, paſs uninterrupted thro' the moſt denſe Clouds and thickeſt Rain. But this is uſually in warm Weather, not in Winter. And it is the ſame with Phoſphorus. It very frequently flaſhes in warm Weather, but very rarely in Winter.

AGAIN. The Flame of Lightning is generally inoffenſive, and does not ſet fire to any thing. In like manner the Flaſhes of Phoſphorus are harmleſs, and do not ſet fire to the moſt combuſtible matter. But when condenſed Phoſphorus is ſet on fire, it burns terribly. And in the ſame manner Lightning when condenſed, burns Trees, Houſes, or whatever it comes near. Phoſphorus while burning acts as a Corroſive, and when it goes out, forms a Menſtruum, which diſſolves Gold, Iron and other Metals. Lightning melts the ſame Subſtances.

ANOTHER kind of artificial Phoſphorus, is a preparation of the *Bononian* Stone. This Stone is of no certain Figure, but is ſometimes round, ſometimes oblong,

long, or lenticular. They are uſually as big as an Orange, but very light, conſidering their Bulk. They are of various Colours, ſome aſh-coloured, ſome blue, and ſome almoſt white. When this Stone is prepared, it receives Light, but in very different degrees, either from the Sun, the Moon, common Day-light, or a Flame. After it has been expoſed a few Minutes to any of theſe, it ſhines in the dark like a burning Coal, with ſuch a Light as is ſufficient to read by, if the Letters be held near the Stone. It does not retain its Light long, but requires often renewing. When well prepared, it will retain this virtue for five or ſix Years. It appears to moſt advantage, if brought into a dark Room, after being held in the Sun.

3. When the Rays of Light fall on opake Bodies, they are variouſly reflected to our Eyes, according as the Surfaces of thoſe Bodies are variouſly diſpoſed. And hence ariſes our Senſation of *Colours*. Theſe, as they exiſt in the coloured Bodies, are only the Diſpoſitions of their Surface, to reflect ſuch particular ſorts of Rays. *White* Bodies reflect all Rays every way, without any Separation of them. On the contrary, *Black* Bodies imbibe all the Rays, and reflect none or very few. Whereas *blue*, *yellow* and *red* Bodies, reflect only one particular Sort of Rays. The ſmalleſt ſort of Rays are ſuppoſed to be blue; the next, yellow, the largeſt red.

To be a little more particular. There are eight true, *primary* Colours, which are red, yellow, green, blue, violet, purple, orange and indigo. All the reſt are compounded of theſe, and are termed *Secondary* Colours. But the more compound any Colour, the leſs vivid it is. And by too much Compoſition, they may be diluted and weakened 'till they are deſtroyed. The moſt extraordinary Compoſition of all is that of *Whiteneſs*. For to this all the Primary Colours are required, as alſo, that they be mixt in a certain degree. And hence White is the ordinary Colour of Light: Light being an Aſſemblage of all Colours.

The Tranſmutation of Colours by mixing them together, is not real, but merely apparent. Thus mix blue and yellow Powders, and they appear Green. But view them with a Microſcope, and the blue and yellow Particles are ſeen as diſtinct from each other as before.

To produce *Black*, the Particles muſt be leſs than thoſe which exhibit any other Colour. Where they are greater, there is too much Light reflected to conſtitute this Colour. But if there be a little leſs than forms the Indigo, the Body appears intenſely black.

And hence it appears, why Fire and Putrefaction turn many Subſtances black. They divide them into exceeding ſmall Particles, which then abſorb inſtead of reflecting the Light. Hence alſo it appears, why Glaſs ground very elaborately with Sand on a Copper Plate, makes the Sand together with what is worn off from the Glaſs and Copper, become very black: Likewiſe, why Black Subſtances expoſed to the Sun, are hot ſooner than any other. This may partly proceed from the multitude of Refractions in a little room, partly from the eaſy commotion of ſo ſmall Particles, and from their imbibing his Rays. Hence alſo we learn, why Blacks are uſually inclined to a bluiſh Colour. Black borders on Indigo, and therefore reflects Indigo-rays, if any.

To try if Black Bodies receive Heat more than others, Mr. *Boyle* whited one half of a Tile, and blacked the other, and then expoſed it to the Summer-Sun. While the white Part ſtill remained cool, the black Part was grown very hot. For farther Satisfaction, he expoſed to the Sun a Tile part of which was blacked, part white, and part of its natural Red: And after a while found the black part hot, the red warm, and the white cool.

All the *Secondary* Colours of natural Bodies, proceed from their reflecting two or more ſorts of rays together, and abſorbing the reſt.

Glass, Chryſtal, Diamond, and other tranſparent Bodies, loſe their tranſparency and are white, when reduced to powder: The Change of texture cauſing them to reflect the Rays which before they tranſmitted.

White Loaf-Sugar, melted over the fire, without water, firſt turns brown, afterwards black. And a ſingle grain of this tinges a Quart of fair Water with a beautiful Yellow. Violets, Roſes, Carnations and moſt Flowers loſe their Colour, by being long in the open Air. And by the ſame means blue eſſential Oil of Chamomile-flowers changes to a dirty Green.

Many Colours may be produced, deſtroyed and regenerated, upon ſimple Mixture. Let dried Roſe leaves ſtay a while in Spirits of Wine, and they loſe their Colour without tinging the Liquor. But add a little Oil of Vitriol, and it turns red: Put in a little urinous Spirit, and the red changes to green, which by adding a little more Oil of Vitriol, turns to a red again.

Make a ſlight infuſion of bruiſed Galls in water, ſo as not to diſcolour it. Make alſo a weak infuſion of green Vitriol in Water, which will be ſtill tranſparent. Yet mix them together, and an inky Blackneſs will immediately ariſe. But add a little Oil of Vitriol; the Blackneſs will vaniſh and the Liquor be tranſparent again. Yet the Blackneſs may be recalled by adding a little Salt of Tartar.

If a little bruiſed Camphire which is very white, be put into tranſparent Oil of Vitriol, the Camphire will diſſolve, and tinge the liquor firſt brown, and at length a fine Black. But upon the Addition of fair water, the blackneſs entirely vaniſhes, and the Camphire regains its native Whiteneſs.

A transparent infuſion of Sugar of Lead in water being wrote with, when dried becomes inviſible. But the bare Fumes of another tranſparent Liquor, namely, Infuſion of Quick Lime and Orpiment in Water, will quickly make the inviſible Writing black and viſible.

And not only Secondary but Primary Colours are producible by ſimple Mixture. If the Sun's Rays paſs thro' two pieces of differently-colouredGlaſs, ſuppoſe a blue and yellow piece laid on each other, and theſe Rays are received upon white Paper, they produce a beautiful Green. A mixture of the Seven, or even five, Original Colours, will make a pure White. If different Coloured Flames be brought to mix, the Experiment is made to perfection.

FLAMES from different Bodies are of different Colours. The Flame of Camphire is white, of Sulphur blue, of white-wax inclining to yellow. For making Experiments, Oil may be impregnated with different Metals, ſo as to exhibit their particular Flames.

4. AIR is the ordinary Vehicle of *Sound*, which is the fainter, the more remote the ſounding Body is. It is alſo leſſened, and ſometimes quite interrupted, either by contrary Winds, or thick Vapours floating in the Air. It is ſuppoſed, that the ſounding Body, excites a kind of Undulation or tremulous Motion in the Air, raiſing as it were Waves of Air, one of which impells the other 'till they reach the Ear.

SOUND moves but little quicker by having the Wind with it, as it moves at leaſt thirty-three times faſter than the moſt violent Wind we know. But it is heard much farther thereby.

THAT Air is the *grand Vehicle* of Sound, appears from various Experiments. A Bell in an unexhauſted Receiver, may be heard at ſome diſtance: but ſcarce at the ſmalleſt, when it is exhauſted. But it is not the *only* one. Water too will convey Sound. If you ſtrike a Bell under water, the Sound is heard plain, only not ſo loud, and alſo a Fourth deeper. And a Sound made in Air, is heard under Water, with juſt the ſame Difference.

SOUNDS move a mile in Nine Seconds and a quarter. If a Gun be diſcharged with its Mouth to us or from us, the Report comes to us in the very ſame time. All Sounds move with the ſame Swiftneſs, in all States of the Atmoſphere, by day and by night, in Summer and in Winter, in ſnowy or clear Weather, and in all Climates. A weak and a ſtrong Sound move with equal Swiftneſs. It always moves the neareſt way, and equally ſwift from the beginning to the End of its Motion.

IF the undulating Air ſtrikes againſt hard, concave Bodies, it rebounds and occaſions what we call an

Echo. As often as a Sound ſtrikes perpendicularly on a Wall, behind which is any Vault or Arch, or even a parallel Wall, ſo often it will be reverberated in nearly the ſame Line. For a multiplied Echo, there muſt be a number of Walls and Cavities, either behind, or fronting each other.

The Echo in *Woodſtock-Park* returns very diſtinctly, in the Day Seventeen, in the Night, Twenty Syllables. There is an Echo on the Bank of the River *Naſſa*, between *Bingen* and *Collentz* in *Germany*, which repeats what is ſaid ſeventeen times. And, what is ſtill more peculiar, the perſon who ſpeaks is ſcarce heard at all, but the Repetition clearly, and with ſurprizing Variety: The Echo ſeeming ſometimes to approach nearer, ſometimes to be farther off. One Perſon hears only one Voice, another ſeveral: One hears it on the right, another on the left.

Two Miles from *Milan* there is a ſtill more ſurprizing Echo. It returns the Sound of a Piſtol fifty-ſix times. The firſt repetitions follow one another very quick: but they are more diſtinct in proportion as they decay. There are two parallel Walls, which beat the Sound back upon each other.

5. The fine *Effluvia* from odorous Bodies, when they reach our Noſtrils excite the Senſation of *Smelling*. Some Bodies emit theſe moſt when they are moiſt: Some only when they are warmed or heated. From all ſuch Bodies innumerable Particles flow, which according to their various Size, Figure and Motion, variouſly affect the Olfactory Nerve. But what particular Motion, Size or Figure, is required in order to any particular Smell, who is able to explain? Theſe Effluvia indeed are inconceivably ſmall: So that Amber and divers other odorous Bodies, emit them for many Years, without any diſcernible Loſs, either as to Bulk or Weight.

Mr. *Boyle* ſhews, 1. That the number of Particles thus emitted, is exceeding great, 2. That they are of a very penetrating nature, 3. That they move with vaſt Swiftneſs and in all Directions, 4. That there is often a wonderful Congruity between the Bulk and Shape of theſe Effluvia and the Pores of the Bodies they penetrate, and laſtly, that they may excite great Motions and thereby make great Changes in organized Bodies.

THAT Effluvia are emitted to a very great diſtance we learn from hence, that Wines grow turbid in the Hogſhead, preciſely at the time that the Grapes are ripe in the Country whence they were imported. That they are very penetrating, even without loſing their virtue we have a proof from the Loadſtone, whoſe Effluvia paſs thro' the moſt ſolid Bodies, without any Change of their Force. That they occaſion great Changes in organized Bodies, we have a remarkable Proof in a Caſe lately publiſhed by Dr. *Heiſter.* " Making an Afternoon's Viſit to the Reverend Mr. *Sontag*, he received me in an Apartment, where there were three or four Flower-pots with white Lillies. I aſked him, if he did not find his Head affected, when he continued long in the room where they were, and told him, Phyſicians thought them dangerous, and I myſelf could not bear them. I therefore begged, the Window might be opened, that the Effluvia might be diſperſed.

HE ordered the Window to be opened, and replied, He found no Inconvenience from them, being a tall, ſtrong, healthy Man. But the Smell being ſtill too powerful for me, I was obliged to take my leave of him, ſooner than I intended.

THE Night following, he was ſeized with an Apoplexy. Dr. *Bayer* and myſelf were ſent for. We found him with his Eyes wide open, but without Speech, Senſe or Motion. I told Dr. *Bayer* what had paſſed the Day before. We ordered Bleeding, Bliſters, and ſtrong Friction of the Soles of the Feet, Head and Hands, with the other Remedies uſual in thoſe Caſes: But without Succeſs: for the next Morning he began to rattle in the throat, and ſoon after, died."

THIS may admoniſh thoſe to whom thoſe Odours are not ſenſibly prejudicial, not to ſtay long within the Sphere of their Activity.

IN ſome Places Effluvia from the Earth, produce many Effects on the Surface of it. The bubbing and boiling Fountains in *England* and other Countries are chiefly occaſioned by the burſting up of their Effluvia. Our burning Well in *Lancaſhire*, has no peculiar Property in its Water: But an inflammable Vapour riſing thro' it, makes it boil and bubble on the Surface. And this Vapour as ſoon as ſet at liberty from the Water, will take flame at a lighted Candle. The famous boiling Spring near *Montpelier*, is likewiſe no other than common Water, 'thro which a Vapour of the ſame kind makes its way. Indeed all the Springs thereabouts, bubble more or leſs; the Vapour making its way thro' the whole Surface of the Earth. Water taken out of that Spring has no ſuch Property, nor any peculiar Taſte or Virtue. What is a farther Proof is, the Cracks of the Earth thereabouts, all perſpire ſtrongly a Vapour of this kind: So that if Straws be laid on the Surface, they will be blown up, and if an Hole be any where dug in the ground, and Water poured into it, it will boil up in the ſame manner as the Spring.

THE like ſort of Springs are common in *Switzerland*, and ſome other Places. Theſe are known to be owing to Effluvia from beneath, by the Water of them being cold. But there are others which actually boil, and are hot enough to boil an Egg. Such are the famous boiling Fountains, of *Solfatara* near *Naples*.

FROM theſe various Springs we find that there is much Variety of this kind of Exhalations: Some being cold and dry: Some of a bituminous Nature, and not actually cold, as ours in *Lancaſhire*: Some hot, as thoſe in the ſweating Vaults and Caverns, and in the Mountains of *Italy*. Others are of a poiſonous Nature, containing Particles of Arſenic or other poiſonous Minerals.

6. MANY Bodies are taſtleſs. But ſome even of theſe may contract a very ſtrong *Taſte* (as do ſeveral Metals) when they are reſolved into a fine Powder. Some Bodies, by ſeveral other Changes, acquire Taſtes which they had not before, or variouſly increaſe, leſſen or alter their Taſte. Hence it has been ſuppoſed,

That all Taſtes proceed from Salts, which are often ſo inveloped, that they cannot exert their Power. But if the containing Bodies are diſſolved by Fire or Liquors, then they variouſly affect the Nerves in the Tongue and Palate. And hence ariſe all the various Senſations of Taſte. But what particular Size, Shape or Motion of the Particles, is required to produce any Particular Taſte, all our Skill cannot determine.

7. Of the Properties which we perceive by *Feeling*, the chief are *Moiſtneſs*, *Dryneſs*, *Heat* and *Cold*. There is no *Heat* without Fire, or at leaſt ſome Diſpoſition of the heated Body to take fire. If the Particles of it, rapidly agitated, ſtrike againſt another Body, they tear and diſſolve it: If againſt the Body of a Man, the Senſation of Heat ariſes in the Mind. Some ſuppoſe, *Cold* conſiſts in the Reſt of thoſe Particles which were ſo agitated before. Others think this would not ſuffice to produce that acute Pain which we ſometimes feel from Cold; and therefore ſuppoſe there are poſitive frigorific Particles, which move on in ſtrait Lines, and ſo only deſtroy the Circular Motion which is required for Heat, but likewiſe penetrate the Body, and ſharply affect the Extremities of the Nerves.

8. *Gravity* and *Levity* have likewiſe been reckoned among ſenſible Qualities. But properly, there is no ſuch thing as Levity, for all Bodies tend to the Center of the Earth, tho' ſome are *light* in compariſon of others. The Laws of Gravity are 1. All Bodies on the Earth, tend to a point which is (nearly at leaſt) the Center of the Globe. 2. In all places equidiſtant from the Center, the Force of Gravity is nearly equal. 3. Gravity equally affects all Bodies, without regard either to their Bulk or Figure. So that were it not for the Reſiſtance of the Medium, the greateſt and ſmalleſt Bodies, the moſt denſe and the moſt rare, would deſcend equal Spaces in equal times. Thus Gold and Feathers deſcend alike in an exhauſted Thermometer. 4. This Power increaſes as we deſcend to the Center, and decreaſes as we aſcend from it: And that as the Squares of the Diſtances. Thus at a double Diſtance, things have but a Quarter of the Force.

5. Thoſe things ſwim in Fluids, which are ſpecifically (that is, Bulk for Bulk) lighter than thoſe Fluids.

This gravitating Power ſeems to be congenial to Matter. It penetrates even to the Center of the Sun and other Heavenly Bodies, without any Diminution of its Virtue. And it acts, not according to the Surfaces of Bodies, as Mechanical Cauſes do, but according to the Quantity of Matter they contain. That it is an original Law of Nature, immediately impreſt by the Creator, without dependence on any Second Cauſe at all, may appear from the following Conſiderations. 1. Gravity does not require the Preſence of the gravitating or attracting Body. 2. The Diſtance being the ſame, the Velocity wherewith gravitating Bodies move, depends on the Quantity of Matter in the attracting Body. And the Velocity is not changed, let the Maſs of the gravitating Body be what it will. 3. If Gravity depend on any known Law of Motion, it muſt be ſome Impulſe from an extraneous Body: Whence, as Gravity is continual, a continual Stroke muſt alſo be required. Now if there be any ſuch Matter continually ſtriking on Bodies, it muſt be ſubtle enough to penetrate all Bodies. But how ſhould Matter ſubtle enough to penetrate the hardeſt Bodies, and ſo rare as not ſenſibly to hinder the Motion of any, be able to impel ſuch vaſt Bodies toward each other with ſuch force? How does this Force increaſe, according as the Maſs of that Body, toward which any Body moves, increaſes? Whence is it, that all Bodies at the ſame Diſtance from the Body gravitated to, move with the ſame Velocity? And how can Matter, which only acts on the Surface of the Bodies themſelves, or of their internal Particles, communicate ſuch Motion as in all Bodies ſhall exactly follow the proportion of the Quantity of Matter in them?

But after all comes Mr. *Hutchinson*, calls Sir *Isaac* and all his Followers ſenſeleſs, unphiloſophical Blockheads, and to ſolve all the Difficulty in a moment, ſuppoſes the Sun to be the Center of the whole Univerſe, and to project *Light* every way, thro' every point of Space, to the utmoſt Circumference of it. When this Light arrives at the Circumference, it is condenſed into larger Maſſes, and returns in the form of *Spirit* or *Air*, thro' every point of Space to the Sun. There it is again comminuted into Light by the immenſe *Fire*, and ſo iſſues out again to the Circumference. And this double Impulſe of *Light* moving outward, and *Spirit* moving inward, cauſes the Motion of all the Heavenly Bodies, both round their own Axles and round the Sun. But to wave that groſs Abſurdity, of ſuppoſing every Point of Space to be continually filled with Light, and every point of it to be filled with Spirit at one and the ſame time, (which is flatly impoſſible, ſince both are Material, and two Particles of Matter cannot cöexiſt in the ſame Space :) How does this remove the Difficulty at all? How does it help us forward an hair's breadth? For what impells Light outward, or Spirit inward? It can be no mechanical Power. It muſt then be the Finger of GOD. And if ſo what have we gained? May we not as well ſay at once, (as go thus round about) "Gravitation can be no otherwiſe accounted for, than by allowing the direct, immediate Power of GOD, operating thro' the whole Univerſe?"

BUT beſide the *Attraction* of *Gravity*, there is another Species of Attraction, between the minute Particles whereof Bodies are compoſed. Theſe attract each other at or near the point of Contact, with a force much ſuperior to that of Gravity. It is by this *Attraction* of *Coheſion*, that the Atoms or inſenſible Particles of Bodies are united into ſenſible Maſſes. Hereby numberleſs Phænomena may be accounted for, which are otherwiſe inexplicable: Such as Coagulation, Chryſtallization, the Aſcent of Fluids in capillary Tubes. Such likewiſe are Fermentation, Animal Secretion, and many others. Thus Nature will be found very ſimple and conformable to herſelf, performing all the great Motions of the Heavenly Bodies, by the Attraction of Gravity between thoſe Bodies, and almoſt all the Motions of their ſeveral Parts, by this Attraction diffuſed thro' every Particle. Sir *Isaac* thinks, that without theſe two Principles there would be no Motion in the World. And without the continual Operation of them, it could not long continue, conſidering the vaſt and conſtant Diminution of Motion by various other Cauſes.

Mr. *Hervey's* Obſervations on this head, are ſtrong and beautiful. "The fundamental Laws of our modern Aſtronomy are *Projection* and *Attraction:* One the all-combining Cement, the other the ever operative Spring of the mighty Frame. In the Beginning God impreſſed a proper Degree of Motion on each of the whirling Orbs. This, if not controlled, would have carried them on in ſtrait Lines, till they were loſt in the Abyſs of Space. But the Principle of *Gravitation* being added thereto, determined their Courſe to a circular Form. And how neceſſary for the Conſervation of the Univerſe, is both the one and the other? Were the Projectile Power to ceaſe, all the harmoniouſly-moving Spheres would fall into the Central Fire. Were the Gravitating, they would exorbitate into wild Confuſion, or by their rapid Whirl be diſſipated into Atoms. But the Impulſive and Attractive Energy, being nicely attempered to each other, the various Globes perſevere in their radiant Courſe, without any Interruption or diminution.

How extenſive, and how diverſified is the Force of this ſingle Principle of *Attraction?* (Underſtanding by the Word, that of Coheſion, as well as of Gravitation!) It penetrates the very Eſſence of all Bodies, and diffuſes itſelf to the utmoſt Limits of the mundane Syſtem. By this all thoſe vaſt Worlds of Matter hang ſelf-ballanced on their Centers. And to this is owing an Effect of a very different nature, the *Preſſure* of the Atmoſphere, which tho' a yielding and expanſive Fluid, yet by virtue of an attracting Energy, ſurrounds the whole Globe of Earth, and incloſes every Creature thereon, as it were with a tight Bandage: An Expedient abſolutely neceſſary to preſerve the Texture of our Bodies, and indeed of every Animal. Urged by this, the *Rivers* circulate with a never-failing Current, along the Veins of the Earth. Impelled by the ſame myſterious Force, the *nutritious Juices* are detached from the Soil and aſcending the trunks of Trees find their way thro' millions of the fineſt Meanders, in order to convey vegetative Life

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into the ſmalleſt Branches. This confines the *Ocean* within its Bounds. Tho' the Waves thereof roar and ſwell, yet checked by this Curb, they are unable to paſs, even the ſlighteſt Barrier of Sand. To this the *Mountains* owe that unſhaken Firmneſs, which laughs at the ſhock of careering Winds. By virtue of this inviſible Mechaniſm, without any Inſtrument of human Device, thouſands of Tons of Water are raiſed every moment into the Regions of the Firmament. By this they continue ſuſpended in the Air, without any Ciſtern to contain them. By the ſame variouſly-acting Power, they in due time drop down again, in gentle Falls of *Dew*, or are precipitated in copious Showers of *Rain*. They ſlide down in fleecy flights of *Snow*, or dart in clattering Showers of *Hail*. This occaſions the ſtrong *Coheſion* of *ſolid Bodies*, without which our large Machines would be utterly uſeleſs, and the nicer Utenſils of Life elude our Expectations of Service. In ſhort this is the *Ballaſt* which compoſes the Equilibrium, and conſtitutes the Stability of things: This the great *Chain*, which forms the Connexion of univerſal Nature, and the mighty *Engine*, which in good meaſure accompliſhes almoſt all her Operations. What complicated Effects from a ſingle Cauſe! What Profuſion amidſt Frugality!

How extremely plauſible is all this! And what pity, that it is only *plauſible!* But it is really no more: It is not capable of any ſubſtantial Proof: I mean, with regard to the Motion of the Heavenly Bodies, and the Cauſes of that Motion. I do not know that any one has yet given a rational Anſwer to Dr. *Roger's* Obſervations on that Head. "The Action of theſe Two Powers, (*Gravitation* and *Projection*) is inadequate to ſuch a Motion: Becauſe in order to produce it, the gravitating Force muſt exactly ballance the Projectile: But were this done, one would deſtroy the other. This will appear plain, if we conſider the Nature of theſe two Forces. Gravitation, by which the Earth attracts all Bodies, is at all times uniformly exerted in right lines, from the Earth to the Body attracted, and acts equally on all Bodies according to their Denſities. It is perpetual, ſubject to no decay, needing no Reparation. But Projection is a Motion given to a Body, contrary to its Nature. When given, it would always continue in a ſtrait Line, if nothing hindered it; but cannot remove any Obſtruction, without loſing Part of its own force. Now the Obſtruction given by Attraction muſt have the ſame Effect, as Obſtruction given by Air or Æther. It muſt continually leſſen any projectile Force, till that Force is totally deſtroyed.

A MORTAR elevated forty-five degrees ejects a Bomb at firſt in or near a right line, while the projectile Force is vaſtly ſuperior to the attractive: Afterwards in a Curve: For the moment the two forces are in æquilibrio, in a ſegment of a Circle; then in a Curve leſs and leſs bent, till it falls in a right line to the Center of Gravitation.

THIS is the Nature of all Projectiles: Nor can any Projectile thrown in any Direction, by any force of Attraction, produce a circular Motion: Much leſs an Elliptical one, ſuch as that of the Earth. Beſides, what Phyſical Reaſon can be aſſigned, why the Earth being nearer the Sun in Winter, the gravitating force does not increaſe; and why the Projectile does not increaſe in Summer, when it is farther from the Sun, to the entire Deſtruction of one or the other.

A THIRD Motion alſo is ſuppoſed to be primarily impinged on the Earth, namely round its own Axis. But nothing can be more plain, than that a Body ſo ſtrongly attracted by the Sun, as to keep it from flying off in a Tangent, muſt have its circular Motion preſently ſtopt: As the Side next the Sun muſt be attracted moſt, the Attraction of all the Planets co-operating thereto.

To make this plain, I hung a Loadſtone to a ſmall ſtring, and gave it as many turns as would continue its revolving Motion ten Minutes and an half, when no Iron was near. But on bringing a piece of Iron near, it ſtopped. The Iron being removed, it recommenced its circular Motion, which laſted for a Minute more. Hence it is evident, that did not ſome Force continually act upon the Earth, to keep up its

Motions, the attractive Power of the Sun, would ſoon ſtop, at leaſt the diurnal one.

THE Friction likewiſe of the Ether muſt be conſiderable. Elſe why might not the Earth revolve in twenty four Minutes as well as 24 Hours? Indeed this ſeems to be one great Uſe of the Ether, to prevent the too rapid Motions of the Planets. And as the Earth floats in the Air, ſo does the Sun in the Ether, his proper Atmoſphere, which extends to the utmoſt limits of his Syſtem, and is the Medium, the Funiculi or Hami, by which he attracts all the Planets and Comets, and prevents their flying out of the Syſtem.

NEITHER will Gravitation at all account for the Motion of Comets. That in 1680 deſcending from an immenſe Height perpendicularly toward the Sun, roſe from him again with equal Velocity. Now as its Acceſs to, and Receſs from the Sun, were made in ſtrait lines, while they were making, the Projectile force muſt ceaſe. But to ſtop any Projectile, is to deſtroy its Motion. How came it then to be ſo ſtrongly exerted in the Perihelion? Was there a continued Miracle, a freſh Projection given? Or did it rebound? What, from the yielding Ether?

AGAIN. This Comet, during half its Circuit round the Sun, was diſtant from it but one third of the Moon's diſtance from the Earth. The Attractive Force therefore was then vaſtly increaſed; and the projectile being deſtroyed, it muſt have impinged on the Sun long ago, had there been no other Force to prevent it. It is clear then upon the whole, that the Motions of the Heavenly Bodies, cannot be accounted for, by Attraction and Projection.

How then can they be accounted for? Poſſibly thus. The Earth being an oblate Spheroid, objected to the Sun in an obliquity of 66 Degrees, 30 Minutes, (the ſame which given to the Sails of a Windmill, occaſions its moſt forcible Converſion) the Sun's Rays ſtriking againſt the oblique Hemiſphere, as the Wind againſt the Sails of a Windmill, keep it off, and at the ſame time, make it turn on its own Axis. The Ether being a reſiſting Medium, and the Atmoſphere (like the Oars of a Boat) ſtriking therein, urges it into a progreſſive Motion. Meantime its own Gravity inclines it to the Sun's Center, and of courſe keeps it in equilibrio, with the repelling Rays.

It is ſuppoſed likewiſe, that the Plane of the Earth's Orbit, is in Winter in or near the Sun's Axis, whence the Rays are not ſo forcibly emitted; for which cauſe the Earth muſt then come nearer, the repelling force being weaker. But in Summer being objected to the more forcibly repelling Rays, it muſt be driven to a farther diſtance; whence its Annual Orbit muſt become Elliptical.

The Earth's Diameter being known, determines its Diſtance from the Sun. For as the Diameter is 7967.8, the Periphery 25031, which multiplied by the number of its Revolutions 365.25 gives for its Orbit 9,142,572: And as it moves thro' this Orbit merely by the impulſe of the ſolar Rays, and as the Gravitating Force muſt neceſſarily be equal to that impelling force: So while it rolls onward one mile, it is attracted another. Conſequently the preceding Orbit being doubled, by the gravitating Force, makes in all 18,285,144. The Semi-diameter of this is the Diſtance of the Earth from the Sun: Which therefore is neither more nor leſs than 2,910,164 miles.

In the ſame manner we find the diſtance of Venus from the Sun to be 1,790 684 miles: That of Mars, 5,473,690: That of Jupiter 34,520,432; that of Saturn 85,727,320, and that of Mercury 700,758.

And as theſe Diſtances are far leſs than thoſe aſſigned by the modern Aſtronomers; ſo is the Magnitude of the Heavenly Bodies proportionably leſs than they ſuppoſe. For inſtance: The Diameter of the Sun, commonly ſuppoſed to be 822,148 miles, is according to this manner of calculating, 23,373 and no more. And that this is nearly the true Diameter, and theſe the true Diſtances, appears from Experiments on the Tranſits of the Planets over the Sun.

The Comets Dr. Rogers thinks are chiefly deſigned to repair the Quantities of Light continually emitted by the Sun, and which are ſcattered and diſperſed over the whole Syſtem. Their ſweeping Tails which extend ſo many thouſand miles, ſeem adapted to ſuch a purpoſe. And as many of thoſe Particles of Light, are driven to a vaſt diſtance, it is neceſſary they ſhould go to the utmoſt Limits of the Syſtem, to make ſuch a Collection.

SUPPOSE a Body fit for this, detached from the neighbourhood of the Sun, it ſhould be light, porous and ſpongy. And ſuch a Body would be propelled by the violence of the Rays, with great velocity to a great diſtance. The farther it goes, the fewer Rays ſtrike upon it, and their force likewiſe is diminiſhed. The Comet then ſlowly ſweeps his Tail over the wide Expanſe, beyond the Orb of Saturn. There its Cells are filled with the Matter it was ſent to collect; but becoming heavier, the other Scale begins to preponderate, and he ſlowly returns toward his Center. His Collection increaſes as he deſcends, which adds to his Weight and Swiftneſs, and he comes down, if very heavy, almoſt in a ſtrait line, if leſs ſo, in a larger Curve, 'till he is near the Sun, where having emptied himſelf, and being evenly ballanced with the repelling Rays, he moves round in the ſegment of a Circle, 'till being continually lighter, he is no longer a Ballance for the repelling Rays, and ſo is driven forward thereby, and runs the ſame Circle as before.

WHAT a violent Blow is here given to the whole Fabric of Modern Aſtronomy! And how can any reaſonable Man ſubſcribe thereto, till this Difficulty is removed?

9. There is no need to ſpeak particularly of thoſe other Qualities, *Hardneſs*, *Softneſs*; *Firmneſs*, *Fluidity*: *Brittleneſs*, *Toughneſs*; *Roughneſs*, *Smoothneſs*; *Denſity*, *Rarity*: *Rigidity*, *Flexibility*, *Compreſſibility*, *Elaſticity*. What each of theſe is, we know well, without any elaborate Definition. And in general we know, that they all ariſe, from the various Figure, Situation and Texture of the Particles whereof Bodies conſiſt. But farther than this we know not. What particular Shape, Texture or

Situation, is requiſite in each caſe, is a matter of mere Conjecture.

10. THOSE of which we are not able to give any rational account, have often been termed *Occult Qualities.* Among theſe is uſually ranked that *Sympathy*, which is obſerved in things diſtant from each other. So Onions in the Granary ſprout, while others ſprout in the Garden. So nothing is more common, than that if you throw a Mulberry or Strawberry at a Woman with Child, the Child has the mark of one or the other, on the ſame Part which was ſtruck with it. And theſe Marks grow green, yellow and red every Year, juſt as thoſe Fruits do in the Garden. And when the Seaſon of them is paſt, theſe ſubſide and vaniſh away. So Women ſtartled by a ſudden Sight of the Moon, have ſtamped the Figure of the Moon on their Children. And this Figure increaſed or decreaſed juſt as the Moon did. Oppoſite to this is that amazing *Antipathy*, which ſome things appear to have naturally for each other. Inſtances of which are found, not only in Men, but in Animals, if not in Plants alſo.

BEFORE we attempt to account for any of theſe things, we ſhould take care to be well aſſured of the Fact. For many of them are generally believed and vehemently aſſerted, which yet never had any being. Hence others run into the oppoſite Extreme, roundly denying whatever they cannot account for. The middle Way is beſt. Firſt, be ſure of the Fact. Then, try if it can be accounted for on allowed Principles. And if it can, the Qualities in queſtion, are to be termed *Occult* no longer. But there will ſtill remain many Secrets in Nature, which we are in no wiſe able to account for. Indeed, to penetrate the inmoſt Receſſes of Nature, is above the condition of Humanity. We muſt therefore neceſſarily allow, that there are in this Senſe many occult Qualities. Nay, we are ſurrounded with them on every ſide: Inſomuch that there is ſcarce any thing in the Univerſe, that has not ſome Qualities, which the wiſeſt man on Earth is not able to account for.

11. I HAVE now finiſhed what I propoſed. I have given as ſhort and plain an account as I could, of all that is certain in Natural Philoſophy: In order to direct the whole to its proper End, I have now only to add a few Reflections.

IF we caſt our eyes up to the Firmament, let us ſeriouſly aſk ourſelves, What Power built over our Heads that vaſt and magnificent Arch, and *ſpread out the heavens like a curtain?* Who garniſhed theſe Heavens with ſuch a variety of reſplendent Objects, all floating in the liquid Ether, all regular in their Motions? Who painted the Clouds with ſuch Variety of Colours, and in ſuch diverſity of Shades and Figures, as it is not in the power of the fineſt Pencil on earth to emulate? Who formed the Sun of ſuch a determinate Size, and placed it at ſuch a convenient Diſtance, as not to ſcorch or annoy, but cheriſh all things with his genial Heat? For a ſucceſſion of Ages he never failed to riſe at his appointed Time, or to ſend out the Dawn, as his Fore-runner, to proclaim his Approach. By whoſe ſkilful Hand is it directed, in its diurnal and annual Courſe, to give us the grateful Viciſſitude of Night and Day, and the regular Succeſſion of the Seaſons? That it ſhould always proceed in the ſame Path, and never once ſtep aſide; that it ſhould go on, in a Space where there is nothing to obſtruct, but turn at a determinate Point: That the Moon ſhould ſupply the Abſence of the Sun, and remove the Horror of the Night; that it ſhould regulate the Flux and Reflux of the Sea, thereby preſerving the Waters from Putrefaction, and at the ſame time accommodating Mankind, with ſo manifold Conveniences: That all the innumerable Hoſts of Heaven, ſhould perform their Revolutions, with ſuch Exactneſs, as never once to fail, in a Courſe of ſix Thouſand Years, but conſtantly to come about in the ſame Round, to the hundredth Part of a Minute: This is ſuch an inconteſtable Proof of a Divine Architect, and of the Care and Wiſdom wherewith he governs the Univerſe, as made the *Roman* Philoſopher conclude, " Whoever imagines, that the wonderful

Order and incredible Conſtancy of the heavenly Bodies, and their Motions whereon the Welfare and Preſervation of things depend, are not governed by an intelligent Being, is himſelf deſtitute of Underſtanding. For ſhall we, when we ſee an artfully-contrived Engine, ſuppoſe a Dial or Sphere, immediately acknowledge, that it is the Reſult of Reaſon and Underſtanding: And yet when we behold the Heavens, ſo admirably contrived, moved with ſuch incredible Velocity, and finiſhing their anniverſary Revolutions, with ſuch unerring Conſtancy, make any doubt of their being the Work not only of Reaſon, but of an excellent, a Divine Reaſon?"

But if from that very imperfect Knowledge of Aſtronomy which his Time afforded, even the Heathen could be ſo confident, that the Heavenly Bodies were framed and moved by a wiſe and underſtanding Mind: What would he have ſaid, had he been acquainted with our Modern Diſcoveries? Had he known the immenſe Greatneſs of that Part of the World, which falls under our Obſervation? The exquiſite Regulation of the Motions of the Planets, without any Deviation or Confuſion; the inexpreſſible Nicety of Adjuſtment, in the velocity of the Earth's annual Motion; the wonderful Proportion of its diurnal Motion, about its own Axis; the Denſities of the Planets, exactly proportioned to their Diſtances from the Sun; the admirable Order of the ſeveral Satellits, which move round their reſpective Planets; the Motion of the Comets, equally regular and periodical with that of the other Planetary Bodies; and laſtly, the Preſervation of the ſeveral Planets and Comets, from falling upon or interfering with each other? Certainly could Argument avail, Atheiſm would now be utterly aſhamed to ſhew its Head, and forced to acknowledge, That it was an eternal and Almighty Being, it was God alone, who gave to each of the celeſtial Bodies, its proper Magnitude and Meaſure of Heat, its Dueneſs of Diſtance, and Regularity of Motion: Or, in the Language of the Prophet, who *eſtabliſhed the* *world by his wiſdom, and ſtretched out the heavens by his underſtanding.*

If from the Firmament we deſcend to the Orb on which we dwell, what a glorious Proof have we of the Divine Wiſdom, in this intermediate Expanſion of the Air, which is ſo wonderfully contrived, to anſwer ſo many important Ends at once. It receives and ſupports Clouds, to water the Earth: It affords us Winds, for Health, for Pleaſure, for a thouſand Conveniences: By its Spring it miniſters to the Reſpiration of Animals, by its Motion, to the Conveyance of Sounds, and by its Tranſparency, to the tranſmiſſion of Light, from one End of Heaven to the other. Whoſe Power made ſo thin and fluid an Element, a ſafe Repoſitory for Thunder and Lightning? By whoſe Command and out of whoſe Treaſuries, are theſe dreadful yet uſeful Meteors ſent forth, to purify the Air which would otherwiſe ſtagnate, and conſume the Vapours which would otherwiſe breed various Diſeaſes? By what ſkilful Hand are thoſe immenſe Quantities of Water, which are continually drawn from the Sea, by a natural Diſtillation made freſh, ſent forth upon the wings of the Wind into the moſt diſtant Countries, and diſtributed in Showers over the face of the Earth?

Whoſe Power and Wiſdom was it that hanged the Earth upon nothing, and gave it a ſpherical Figure, the moſt commodious which could be deviſed, both for the Conſiſtency of its Parts and the Velocity of its Motion? Who was it that *weighed the Mountains in ſcales, and the hills in a ballance*, and diſpoſed them in their moſt proper Places, both for Fruitfulneſs and Health? Who diverſified the Climates of the Earth, into ſuch an agreeable Variety, that remote as they are from each other, each has its proper Seaſons, Day and Night, Winter and Summer? Who was it that cloathed the Face of it with Plants and Flowers, ſo exquiſitely adorned with various and inimitable Beauties? That placed the Plant in the Seed, in ſuch elegant Complications, as afford at once both a pleaſing and an aſtoniſhing Spectacle? That painted and perfumed

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Flowers, that gave them the ſweet odours, which they diffuſe thro' the Air for our Delight, and with one and the ſame Water, dyed them into different Colours, ſurpaſſing the Imitation, nay and the Comprehenſion of Mankind? For can the wiſeſt of Men tell,

"Why does one Climate and one Soil endue
The bluſhing Poppy with a crimſon Hue,
Yet leave the Lilly pale, and tinge the Violet blue?"

WHO repleniſhed the Earth, the Water, the Air with ſuch an infinite Variety of living Creatures, and ſo formed, that of the innumerable Particulars wherein each Creature differs from all others, every one is found upon examination to have its ſingular Beauty and peculiar Uſe. Some walk, ſome creep, ſome fly, ſome ſwim. But every one has all its Members and its various Organs accurately fitted for its peculiar Motions. In ſhort, th, Statelineſs of the Horſe and the Feathers of the Swans the Largeneſs of the Elephant and the Smallneſs of the Mite, are to a conſiderate Mind equal Demonſtratione of an infinite Wiſdom and Power. Nay, rather the ſmaller the Creature is, the more amazing is the Workmanſhip. When in the Mite, for inſtance, we ſee an Head, a Body, Legs and Feet, all as well proportioned as thoſe of an Elephant, and conſider with all, that in every Part of this living Atom, there are Muſcles, Nerves, Veins, Arteries and Blood, every Particle of which Blood is compoſed of various other Particles: When we conſider all this, can we help being loſt in Wonder and Aſtoniſhment? Can we refrain from crying out, on this account alſo, *O the depth of the riches both of the wiſdom, and knowledge of GOD! How unſearchable are his works and his ways* of Creation and Providence *paſt finding out!*

NATURAL Inſtinct is another thing in Animals, no leſs wonderful than their Frame: And is indeed nothing elſe than the Direction of an all-wiſe and all-powerful Mind. What elſe teaches Birds to build their Neſts, hard or ſoft, according to the Conſtitution of their young? What elſe makes them keep ſo conſtantly in their Neſt, during he time of Incubation, as if they knew the Efficacy of their own Warmth, and its Aptneſs for Animation? What elſe cauſes the Salmon every year, to come up a River, perhaps hundreds of miles, to caſt its Spawn, and ſecure it in Banks of Sand, till the Young ones are excluded? To go no farther, Can we behold the Spiders Net, the Silkworms Web, the Bees Cells, or the Ants Granaries, without being forced to acknowledge the infinite Wiſdom, which directs their unerring Steps, and has made them fit to be an Emblem of Art, Induſtry and Frugality to Mankind?

If from the Earth and the Creatures that live upon it, we caſt our Eyes upon the Water, we ſoon perceive that had it been more or leſs rarified, it had not been ſo proper for the Uſe of Man. And who gave it that juſt Configuration of Parts and exact Degree of Motion, which makes it ſo fluent, and yet ſo ſtrong, as to carry and waft away the moſt enormous Burdens? Who has inſtructed the Rivers to run in ſo many winding Streams, thro' vaſt Tracts of Land, in order to water them the more plentifully? Then to diſembogue themſelves into the Ocean, ſo making it the common Center of Commerce: And thence to return thro' the Earth or Air to their Fountain-heads in one perpetual Circulation? Who repleniſhed theſe Rivers with Fiſh of all kinds, which glide thro' the limpid Streams, and run heedleſly into the Fiſhers Net, for the Entertainment of Men. The great and wide Sea is a very awful and ſtupendous Work of God. Whoſe Hand makes it ebb and flow with ſuch Exactneſs? A little more or leſs Motion, in the fluid Maſs, would diſorder all Nature, and a ſmall Increaſe of a Tide, might ruin whole Kingdoms. Who then was ſo wiſe as to take exact meaſures of thoſe immenſe Bodies, and who ſo ſtrong as to rule at pleaſure the Rage of that furious Element? He *who hath placed the ſand for the bound of theſe, by a perpetual decree that it cannot paſs.* So that *tho' the waves thereof toſs themſelves, they cannot prevail*; *tho' they roar, they cannot paſs over it.*

If from the World itſelf we turn our eyes more particularly on Man, whom it hath pleaſed the Lord of all to appoint for its principal Inhabitant, no Underſtanding ſurely can be ſo low, no Heart ſo ſtupid and inſenſible, as not plainly to ſee, that nothing but infinite Wiſdom, could in ſo wonderful a manner have faſhioned his Body, and breathed into it a reaſonable Soul, whereby he *teacheth us more than the beaſts of the field, and maketh us wiſer than the fowls of heaven.*

Should any of us ſee a Lump of Clay riſe immediately from the ground, into the compleat Figure of a Man, full of Beauty and Symmetry, and endowed with all the Powers and Faculties, which we perceive in ourſelves, yea, and that in a more eminent degree of Perfection, than any of the preſent Children of Men: Should we preſently after obſerve him perform all the Offices of Life, Senſe and Reaſon; move as gracefully, talk as eloquently, reaſon as juſtly, and diſcharge every Branch of Duty, with as much Accuracy as the moſt accompliſhed man breathing, how great muſt be our Aſtoniſhment! Now this was the very caſe in that moment when God created Man upon the Earth.

But to impreſs this in a more lively manner upon the mind, let us ſuppoſe the Figure above-mentioned, riſes by degrees, and is finiſhed part by part, in ſome ſucceſſion of time. When the whole is completed, the Veins and Arteries bored, the Sinews and Tendons laid, the Joints fitted, the Blood and Juices lodged in the Veſſels prepared for them, God infuſes into it a vital Principle. The Image moves, it walks, it ſpeaks. Were we to ſee all this tranſacted before our eyes, we could not but be aſtoniſhed! A Conſideration of this made *David* break out into that rapturous Acknowledgment, *I will give thee thanks, for I am fearfully and wonderfully made! Marvellous are thy works and that my ſoul knoweth right well. Thine eyes did ſee my ſubſtance yet being imperfect, and in thy book were all my members written.*

Thus which way ſoever we turn our eyes, whether we look upward or downward, without us, or within us, upon the animate or inanimate Parts of the Creation, we find abundant Reaſon to ſay, *O Lord, how manifold are thy works! In wiſdom haſt thou made them all.*

LET us obſerve a little farther the terraqueous Globe. How admirably are all things thereon chained together, that they all aim at the ultimate End, which GOD propoſed in all his Works! And how vaſt a number of intermediate Ends, are ſubſervient to this! To perpetuate the eſtabliſhed Courſe of Nature, in a continued Series, the Divine Wiſdom has thought fit, that all living Creatures ſhould conſtantly be employed in producing Individuals; that all natural things ſhould lend an helping hand, toward preſerving every Species, and laſtly, that the Deſtruction of one thing ſhould always conduce to the Production of another.

THIS Globe contains what are called the three Kingdoms of Nature, the *Foſſil*, *Vegetable*, and *Animal*. The Foſſil conſtitutes the Cruſt of the Earth, lying beneath the viſible Surface. The Vegetable, adorns the face of the Globe, and draws much of its Nouriſhment from the Foſſil Kingdom. The Animal is almoſt wholly ſuſtained by the vegetable Kingdom. If we go deeper into the Earth, the rule which generally obtains with regard to the Strata thereof is this. The upper Parts conſiſt of Rag-ſtone, the next of Slate, the Third of Marble filled with Petrifactions, the Fourth of Slate again, and laſtly, the loweſt which we are able to diſcover, of Free-ſtone.

THAT the Sea once overſpread a far greater Part of the Earth than it does at preſent, we learn not only from Geographers, but from its yearly Decreaſe, obſervable in many Places: Partly occaſioned by the vaſt Quantities of Shells and all kinds of Rubbiſh, which the Tides continually leave on the Shores. Hence moſt Shores are uſually full of Wreck, of dead, teſtaceous Animals, of Stones, Dirt or Sand of various kinds, and heaps of other things. Rivers likewiſe, eſpecially thoſe which have a rapid Stream, wear away whatever they touch, particularly ſoft and friable Earth, which they carry and depoſit on diſtant, winding Shores: Whence it is certain the Sea continually ſubſides, and the Land gains no ſmall Increaſe.

Water retained in low grounds occaſions Marſhes. But what a wonderful Proviſion has Nature made, that many of theſe, even without the Help of Man, ſhall again become firm Ground? More and more moſſy Tumps are ſeen therein. Some of theſe are brought down by the water, from the higher grounds adjoining, and others are produced by putrefying Plants. Thus the Marſh is dried up, and new Meadows ariſe. And this is done in a ſhorter time, wherever the *Sphagnum*, a kind of Moſs, has laid the foundation. For this in proceſs of time, changes into a porous kind of Mold, till almoſt all the Marſh is filled with it. After this the Ruſh begins to ſtrike root, and together with the Cotton-graſſes, conſtitutes a Turf, wherein the roots get continually higher, and thus lay a firm foundation for other Plants, till the whole Marſh is covered with Herbs and Graſs, and become a pleaſant and fruitful Meadow.

I shall add only one Reflection more, with regard to the *Scale of Beings*. As the Microſcope diſcovers almoſt every drop of Water, every blade of Graſs, every Leaf, Flower and Grain of Earth, to be ſwarming with Inhabitants: A thinking Mind is naturally led to conſider that Part of the Scale of Beings, which deſcends lower and lower, from himſelf, to the loweſt of all Senſitive Creatures. Among theſe ſome are ſo little above dead matter, that it is hard to determine whether they live or no. Others that are lifted one ſtep higher, have no Senſe beſide Feeling and Taſte. Some again have the additional one of Hearing: Others of Smell, and others of Sight.

It is wonderful, to obſerve, by what a gradual Progreſſion the World of Life advances, thro' an immenſe variety of Species, before a Creature is found, that is complete in all its Senſes. And among theſe, there are ſo many different Degrees of Perfection in the Senſes, which one Animal enjoys above another, that tho' each Senſe in different Animals, comes under the ſame common Denomination, yet it ſeems almoſt of a different Nature. If after this, we attentively conſider, the Inward Endowments of Animals, their Cunning and Sagacity,

gacity, and what we uſually comprehend under the General Name of *Inſtinct*, we find them riſing one above another, in the ſame imperceptible manner, and receiving higher and higher Improvements, according to the Species in which they are implanted.

THE whole Progreſs of Nature is ſo gradual, that the entire Chaſm from a Plant to Man, is filled up with divers kinds of Creatures, riſing one above another, by ſo gentle an aſcent, that the tranſitions from one Species to another are almoſt inſenſible. And the intermediate Space is ſo well huſbanded, that there is ſcarce a degree of Perfection which does not appear in ſome. Now ſince the Scale of Being advances by ſuch regular ſteps as high as Man, is it not probable, that it ſtill proceeds gradually upwards, thro' Beings of a ſuperior Nature? As there is an infinitely greater Space between the Supreme Being and Man, than between Man and the loweſt Inſect.

THIS thought is thus enlarged upon by Mr. *Locke*. " That there ſhould be more Species of intelligent Creatures above us, than there are of ſenſible and material below us, is probable from hence, that in all the viſible and corporeal world, we ſee no Chaſm, no Gaps. All quite down from Man, the Deſcent is by eaſy ſteps: There is a continued Series of things, that in each remove differ the leaſt that can be conceived from each other. There are Fiſhes that have Wings, and are not ſtrangers to the airy Regions. And there are Birds which are Inhabitants of the Waters, whoſe Blood is as cold as that of Fiſhes. There are Animals ſo near a-kin both to Birds and Beaſts, that they are in the middle between both: Amphibious Animals link the terreſtrial and aquatic together. Seals live either at land or in the Sea: Porpeſſes have the warm Blood and Entrails of an Hog. There are Brutes that ſeem to have as much Knowledge and Reaſon, as ſome that are called Men. Again: The Animal and Vegetable Kingdom are ſo cloſely joined, that between the loweſt of the one, and the higheſt of the other, there is ſcarce any perceptible Difference. And if we go on, till we come to the loweſt and moſt inorganical Parts of Matter, we ſhall find every where, that the ſeveral Species are linked together, and differ in almoſt inſenſible Degrees

Now when we conſider, on the other hand, the infinite Power and Wiſdom of the Creator, does it not appear highly ſuitable, to the magnificent Harmony of the Univerſe, and the infinite Goodneſs of the Architect, that the Species of Creatures ſhould alſo by gentle degrees aſcend upwards from us, (as they gradually deſcend from us downwards) toward his infinite Perfection? And if ſo, is it not probable, there are far more Species of Creatures above than beneath us? Since we are infinitely more remote from the All-perfect Creator, than from the loweſt of all the Works of his hands?

BUT here our Thoughts are loſt. We may conjecture a little; but we *know* nothing. However it is enough, that we *know the only true GOD and Jeſus Chriſt whom he hath ſent.*

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APPENDIX.

AS I have contracted the latter Part of the preceding Treatiſe into a ſmaller Compaſs than I at firſt deſign'd, I purpoſe here to inlarge a little on ſome particulars, which were before but ſlightly mentioned.

ONE of theſe is the *Human Underſtanding*, which was juſt mentioned in the 4th chapter of the Firſt Part. On this important Head I now intend to ſpeak particularly: Chiefly on the plan of the pious and learned Dr. *Brown*, late Biſhop of *Cork* in *Ireland*.

IT is needful, firſt, to trace out the *Bounds* and *Extent* of Human Underſtanding. Theſe Bounds being fixt, we are next to conſider, how the Mind dilates itſelf beyond them; how it ſupplies the Want of direct Ideas, by raiſing up Secondary Images in itſelf: Inſomuch that things otherwiſe imperceptible, grow familiar and eaſy, and we meditate and diſcourſe even on thoſe Beings, whereof we have not the leaſt direct Perception.

CHAP.

CHAP. I.

SECT. I.

Of the Ideas of Senſation.

OUR Senſes are the only Source of thoſe Ideas, upon which all our Knowledge is founded. Without Ideas of ſome ſort or other we could have no Knowledge, and without our Senſes we could have no Ideas. But theſe being once tranſmitted to the Memory, the Soul which till then was ſtill and unactive, being ſupplied with materials to work upon, then begins to exert her Operations.

BEFORE we ſpeak of the Properties of Ideas of Senſation, it is proper to obſerve three things: 1. That it is not neceſſary to decide, Whether Senſitive Perception be performed, by an Impreſſion of the Object, upon the Senſe, or by an Operation of the Senſe upon the Object. It is certain, that either Way all ſenſitive Perception neceſſarily requires the Preſence of the Object, and an immediate Action, either of the Organ upon this, or of this upon the Organ: Conſequent upon which is a ſort of Repreſentation of the Object to the mind. This is the Caſe of all External Objects, which have left any Repreſentation of themſeves with us by our Senſes: Which Repreſentation being tranſmitted by the Senſes to the Memory, is properly termed an *Idea*.

IF any one aſks, what an Idea is, let him look upon a Tree, and then immediately ſhutting his Eyes, try if he retains any Reſemblance of what he ſaw, and that is an Idea. Thus it is that all the Variety of the viſible **Creation**, is let in upon our Mind thro' the

Senſes, as all the Parts of a delightful and ſpacious Landſkip, are contracted and conveyed into a dark Chamber, thro' an artificial Eye in the Wall, and ſo become conſpicuous and diſtinguiſhed in miniature.

NOR, 2. is it material, Whether the Ideas of Senſible Objects are true Images of their Real Natures; or whether the Objects be only the Occaſions of producing thoſe Ideas, by virtue of an arbitrary Law of GOD, That ſuch a Thought in the Soul ſhall follow ſuch a Motion in the Body. For whatever Impreſſion ſenſible Objects occaſion in us, this we call their Idea; it being the only Perception of them we are capable of, and the only Way we now have of knowing them. And ſuch a Way it is, as anſwers all the Ends of Knowledge in this Life, and lays a Ground-work ſufficient for all that Knowledge, which is neceſſary in order to another.

THE Third thing proper to be mentioned is, that, to prevent confuſion, the word *Idea* is in all that follows, confined to the Images we have of ſenſible Objects, and the various Alterations of them by the Underſtanding. And taking the word in this Senſe, the Mind has no Idea of her own Operations. For theſe are originally within us themſelves, and ſo are known by inward Conſciouſneſs: Not as Outward things are, by any Similitude of them, conveyed thro' the Senſes to the Memory.

SECT. II.

Of the Idea of Spirits.

WHEN we obſerve ſuch Effects among Material things, as we know cannot proceed from any inherent Power in them, we neceſſarily infer, There are ſome other Beings not material, which have the power of producing thoſe Effects: Tho' as theſe Beings are imperceptible to our Senſes, we have no Idea of them.

It has been ſaid indeed, That we have as clear an Idea of *Spirit* as we have of *Body*: And to prove this, it is ſaid farther, that we conceive *Thinking*, as clearly as we do *Extenſion*. But what if we did? A pure Spirit, if we ſpeak ſtrictly, does not *think* at all. Thinking is the Property of an *imbodied Spirit*, as requiring the concurrence of material Organs, and being accordingly ever performed to more or leſs Advantage, as theſe are better or worſe diſpoſed. They are ſoon relaxed by the labour of Thought and Attention, and muſt be conſtantly wound up anew by Reſt or Sleep. A Diſtemper puts the whole Machine out of frame, and turns our ſober thinking into Madneſs. And if the Veſſels of the Brain are intirely obſtructed, as in an Apoplexy, we think not at all. How then can we imagine, that a pure Spirit *thinks?* It *knows* indeed; but we cannot tell how: To be ſure, not by playing upon a Set of material Springs, exquiſitely wrought up into a curious Contexture for that purpoſe.

It is becauſe we have no Idea of a Spirit, that we are naturally led to expreſs it by a Negative: to call it an immaterial Subſtance, or ſomething that is not Matter: Something that is not any thing that we know; which forces us to conceive and expreſs it in this imperfect manner.

Yet it has been affirmed farther, That we have as clear an Idea of God himſelf as we have of Man; and that we are as ignorant of the Eſſence of a Man, as we are of the Eſſence of God. Do we not then know, That it is eſſential to Man to be Finite? And have we not a diſtinct Idea of Finiteneſs? But who has any Idea of Infinity, the eſſential Attribute of God? 'Tis plain, we have not: And therefore we expreſs it by a Negative, "Without bound."

Properly ſpeaking we have no Idea of God. We come to our knowledge of his very Exiſtence, not from any Idea of him, but from our Reaſoning upon the Works of the viſible Creation. And hence for want of a ſimple and direct Idea, we form an indirect and very complex Notion of him.

THIS we do in the beſt manner we can, by removing from him all the Imperfections of the Creatures, and attributing to him, all their Perfections, eſpecially thoſe of our own Minds. Yet in truth even theſe cannot be ſuppoſed to be in GOD, as they are in Us. And therefore we are ſaid to aſcribe them to Him only in the *Abſtract:* which is ſaying in other words, That they are of a different Species in the Creator, from what they are in the Creature.

ACCORDINGLY, that there are incomprehenſible Perfections in GOD, anſwerable to Knowledge and Power in Man, whereof theſe are only the faint, tho' true Reſemblances, is natural and eaſy to conceive. But the conceiving his Power as an Ability to change things infinitely, his Knowledge as only Infinite Thinking: the multiplying and inlarging our own Perfections in number or degree only, to the utmoſt ſtretch of our Capacity, and attributing them ſo inlarged to GOD, is no more than raiſing up an unwieldy Idol of our own Imagination, without any Foundation in nature.

THE Sum is this. We have no Idea of GOD, as he is in himſelf. For want of one, we frame the beſt Conception we can, by putting together the Perfections of the Creatures, particularly thoſe we obſerve in ourſelves, to ſtand for his Perfections: Not groſly inferring, That GOD is, in effect, ſuch an one as ourſelves; but concluding, that our greateſt Excellencies, are the apteſt Repreſentations of his incomprehenſible Perfections, tho' theſe infinitely tranſcend the moſt exalted of what are in any created Beings, and are far above, out of the reach of all human Imagination. So true it is, That tho' it may be juſtly affirmed, we can have no Knowledge *without Ideas*, yet 'tis moſt unjuſt and abſurd to infer thence, that we can have no Knowledge *beyond* them.

SECT. III.

The Properties of Ideas of Senſation.

SINCE then the *Ideas of Senſation* are the Foundation and rough Materials, of all even our moſt abſtracted Knowledge, (out of which every man raiſes a Superſtructure, according to the different Turn of thoſe Organs, that are more immediately ſubſervient to the Operations of the Underſtanding, and the different ways in which he employs thoſe Operations :) It will be convenient to ſay ſomething, concerning the Properties of theſe Ideas.

THEIR firſt Property is, that they are *Original.* We receive them from our firſt coming into the world, without any immediate concurrence of the Underſtanding, antecedently to any of its Operations. The Soul till theſe are received is wholly unactive, and cannot ſo much as form one Thought. Theſe Ideas are in reſpect of our ſubſequent Notions, like the firſt Particles of Matter in reſpect of the things compounded of them. They run thro' infinite Changes, as the Mind works upon them, yet in themſelves remain unchangeable. And as our compound Notions are made out of theſe, ſo are they all ultimately reſolvible into them.

IDEAS of Senſation are by this Property diſtinguiſhed,

1. FROM ſuch Ideas as are ſuppoſed to be Innate and antecedent to the Impreſſion of any outward Object.

THAT we have no ſuch Ideas ſufficiently appears even from hence, That we have no Occaſion for them. We have no occaſion for innate Ideas of ſenſible Objects, becauſe there is an obvious Way of obtaining them by the Senſes. And to our Knowledge of Spiritual things, as it cannot be accounted for by innate Ideas, ſo it eaſily may be accounted for without them. The Riſe and whole Extent of this Knowledge is eaſily accounted for, from the Ideas we have of Senſible Objects, the neceſſary Conſequence we draw from their Exiſtence, to the Exiſtence, of things not ſenſible, and from that Manner of conceiving theſe, which we naturally fall into, by the help and mediation of ſuch things, as are within our preſent Sphere.

2. From ſuch Ideas as are ſuppoſed to be acquired by, and ſeated in the Underſtanding, to be the Groundwork of our Knowledge of Spiritual things, as others are of our Knowledge of things Material. Now if there were any ſuch Ideas, we muſt acquire them one of theſe ways: Either

First By the Preſence of the Object itſelf, and its immediate Impreſſion on ſome Faculty diſpoſed to receive and retain the Impreſſion. But every one may be conſcious, that Immortal Objects were never ſo preſent to any Faculty of his Mind, as to imprint and leave upon it any juſt and real Similitude or Reſemblance of themſelves. Or

Secondly, Theſe Ideas muſt proceed from the immediate Power of God. That he *can* impregnate the Mind with them is certain. But how is it proved, That he *does?* If ever he does, 'tis by an Extraordinary Supernatural Act: Whereas we are now ſpeaking, what our Perceptions are, in the Ordinary Way of Nature. Or

Thirdly, The Mind has a power of raiſing up to itſelf Ideas of things whereof it can have no actual View, of Objects which have no Communication, with any of our Faculties. But if it cannot form one Idea of any Material Object, without the actual Preſence of it, much leſs can it frame Ideas of Immaterial Objects, without their immediate Preſence.

Perhaps the Power of raiſing up to itſelf Ideas, without the Preſence or Impreſſion of any Object, is the Privilege of the Divine Mind, anſwerable to that of Creation. But the Power of our Mind in the little world, is much the ſame with that of the whole Man in the Greater. It is as impoſſible for it to raiſe up to itſelf any new Idea, independent of all Senſation, as it is for a man to add one Particle to the common Maſs of Matter.

A Second Property of an Idea of Senſation, is, that it is *Simple*: By which I mean, that it is an Appearance which cannot be reſolved into more than one of the ſame kind.

SIMPLE Ideas are generally confined within too narrow a compaſs. For not only thoſe of Sounds, Smells, Taſtes, Colours and tangible Qualities are ſimple, but the Ideas of all ſingle Bodies. All that ſtrikes the Senſe at once, is to be accounted a ſimple Idea. For you cannot divide the Idea you have of any one Body, into the Idea of more Bodies than One: tho' it may be ſubdivided into the Ideas of the ſeveral Parts of that Body.

BY this Property Ideas of Senſation are diſtinguiſhed,

1. FROM the various Alterations and Combinations of them made by the Mind. The Mind cannot indeed deſtroy any of theſe Ideas, any more than it could create them. But it alters, inlarges or diminiſhes them: it ſeparates and tranſpoſes them; and thus is furniſhed with a New Set of Ideas from within, as well as with ſimple ones from without.

2. FROM thoſe Notions which the Underſtanding forms out of Simple and Complex Ideas, conſidered together with the various Operations of the Underſtanding upon them. Such is the Notion we form of moſt Virtues and Vices: Each of which is apprehended, by Ideas of Senſation, and the Action of the Mind upon them put together into one Complex Conception.

A THIRD Property of Ideas of Senſation is, that they are *Direct* and *Immediate*. Theſe original, ſimple Ideas neceſſarily preſuppoſe the Preſence of the Object and its actual Impreſſion on the Senſe: whence follows a direct and immediate Repreſentation of it, without the intervention of any thing elſe. Thus we could not have had the Idea of a Tree, if the Eye had not actually ſeen it: Nor of a Trumpet's Sound, if ſome of the undulating Air had not actually ſtruck upon the Ear.

By this Property Ideas of Senſation are diſtinguiſhed,

1. From the Ideas we have of thoſe Objects of the ſame kind, which we never actually perceived. Thus the Idea of a man we have ſeen is put for a man we never ſaw: Having no way of conceiving a man that was never preſent, but by ſubſtituting for him the Idea of one that was.

2. From all Conceptions of things which are purely Metaphorical. There are two ſorts of Metaphor, Human and Divine.

Divine Metaphor is the ſubſtituting our Ideas of Senſation, which are direct and immediate, with the Words belonging to them, for the things of Heaven, of which we have no direct Idea or immediate Conception: As when God's Knowledge is expreſſed by *his Eyes being in every Place*, his Power, by a *ſtrong Hand*.

Divine and Human Metaphor agree in this, That the words figuratively transferred from one thing to another, do not agree with the things to which they are transferred, in any part of their literal Senſe. So Hands and Eyes, when applied to God, are not ſpoke in any Part of their literal Signification: As neither is the word *Smiling*, when applied to the Verdure of a Field.

They differ in this, that in human Metaphor, the things for which the figurative Words are ſubſtituted, may be as immediately and directly known, as the Ideas placed in their ſtead. But in Divine Metaphor only, the ſubſtituted Ideas are direct and immediate. We have no direct or immediate Conception of the things they are ſubſtituted for.

3. From all Conceptions of things which are purely Analogical. Divine Analogy is, the ſubſtituting Words that expreſs our Ideas, for heavenly things whereof we have no Ideas. Thus far it agrees with Metaphor: But here lies the eſſential Difference. Metaphorical Words are ſpoke of Heavenly things, in

no part of their proper ſenſe: Analogical, in ſome part of it, tho' not the whole. So the word *Hand* is ſpoken of God metaphorically: for he has no Hand of any ſort whatever. The word *Power* is ſpoken of him analogically: for he has ſome ſort of Power, tho' of a quite different ſort from Ours.

The true Nature of our preſent Knowledge of Divine things, is by the Apoſtle very aptly deſcribed by our *ſeeing in a glaſs darkly*, or *in a mirror, in an obſcure repreſentation.* To ſhew the aptitude and ſignificancy of which Expreſſions, I ſhall obſerve two things:

1. That a Glaſs exhibits to us nothing of the Subſtance of the thing repreſented in it. The Similitude therein having no more of the Eſſence of the thing itſelf than a mere Shadow. Yet we cannot ſay but there is a real Likeneſs of the Subſtance in the Airy Form. There is ſuch a proportion between them, that the Idea of a Face we never ſaw but in a Glaſs, is a juſt one and may well be ſubſtituted for the Face itſelf, of which it gives ſome real Knowledge.

Thus as to thoſe Conceptions which ſtand in our minds to repreſent Spiritual things. Tho' the things they ſtand for are of quite another ſort, and tho' theſe Subſtitutes are no more in reſpect of Them, then a fleeting Appearance in the Glaſs, is to the man repreſented by it: Yet there may be ſuch a Proportion between them as to make our Conceptions of Natural things juſt repreſentations of things ſupernatural. So that the Knowledge we have of them is true, and our Reaſonings upon them ſubſtantial, as long as they are kept within the due compaſs of thoſe Repreſentations. For then it is, that men run into abſurdity, concerning Spiritual things, when not content with this analogical Knowledge, they argue from things Natural to the intrinſic Nature of the Supernatural, and ſuppoſe, that what is affirm'd of theſe Repreſentations only, is literally true of the things they repreſent.

The Second thing I would obſerve concerning this Phraſe is, That in all Inſtances we uſe the ſame Expreſſions, by which we expreſs the things themſelves, for their Appearances in the Glaſs. And indeed juſtly:

for tho' there is nothing of the real Nature of the Objects, in thoſe Appearances, yet ſeeing there is ſuch a proportion between them, the ſame words aptly ſerve for both. So we ſay, We ſee a man in the Glaſs, or the Sun or Moon in the Water, when we ſee only an Appearance, which has nothing of the real Nature of a Man, or the Sun or Moon. And there is ſuch a Proportion between the Object and its Appearance, as would give us ſome Idea of it, tho' we had never ſeen it, but in a Glaſs or in the Water.

By what has been already ſaid, Analogy in general may be eaſily diſtinguiſhed from Metaphor. But becauſe the Diſtinction between this and Divine Analogy is of ſo great Importance, I ſhall ſet the difference between theſe Two in a clearer and oppoſite Light.

METAPHOR expreſſes an Imaginary, Analogy a Real Correſpondence: Metaphor is no more than an Alluſion, Analogy, a Subſtitution of Ideas and Conceptions. The Intention of Metaphor is only, to expreſs more emphatically ſomething known more exactly before: The Intention of Analogy, to inform us of ſomething which we could not have known without it. Metaphor uſes Ideas of Senſation to expreſs things whereto they have no real reſemblance: Analogy ſubſtitutes our Notions and complex Conceptions, for things to which they have a real Correſpondence. To conclude; Words applied metaphorically are not underſtood in any Part of their proper Senſe: Analogical Words are underſtood in a Part, tho' not the whole of their literal Meaning.

CHAP. II.

SECT. I.

Of the Pure Intellect and its Operations.

HAVING hitherto conſidered the Ideas of Senſation as the only Materials the Mind of Man has to work upon, I come to treat of the Mind itſelf, or the *Pure Intellect*. I do not mean by this, the Immaterial Part of us, nor yet the moſt refined and exquiſite Parts of the Body, which are immediately ſubſervient to its nobler Operations: but both of theſe operating together in eſſential Union.

OUR preſent Knowledge is gradually performed, by the concurrent Motion of ſome Bodily Part within us; which is the Cauſe of that Wearineſs we feel, after long-continued thinking. We ſhould never be tired with this, if the Pure Spirit could reaſon independently of all Material Organs. But Experience ſhews us, the caſe is otherwiſe: We find it a Labour to the Brain, and feel ourſelves as much wearied with intenſe Thought, as with hard bodily Labour: Having premiſed this of them in general, I proceed to conſider the Particular Operations of the Intellect, which preſuppoſe Senſation and contain the whole Proceſs and utmoſt Extent of Human Underſtanding.

THE firſt of theſe is a ſimple View or Survey of the Ideas of Senſation, juſt as they lie in the Memory. This the Logicians have rightly termed *Simple Apprehenſion*; but they generally confound it with pure Senſation, whereas it is eaſy to obſerve theſe eſſential Differences between them. 1. In Simple Apprehenſion the Mind is often Active, in Senſation always Paſſive: 2. Simple Apprehenſion preſuppoſes Senſation, and is always ſubſequent to it: 3. By Senſation the Mind receives Ideas; by Simple Apprehenſion ſhe ſurveys thoſe already received.

THE Second Operation of the Intellect on the Ideas of Senſation is *Judgment*. This may be divided into ſeveral Species; the moſt conſiderable of which are theſe that follow.

1. THE *Separating* our Ideas from each other, and ranging them under diſtinct Heads:

2. THE *comparing* them with each other and obſerving their Agreements or Diſagreements:

3. THE *enlarging* or *diminiſhing* them. So we can enlarge the Idea we have of a Tree to any Size, even to reach the Clouds; or diminiſh it in our Thoughts, 'till we reduce it to what it was in its firſt Principle or Seed.

4. THE *dividing* or *compounding* them. So we divide any ſimple Idea into its ſeveral Parts, or compound the Ideas of ſeveral Houſes, to make up that of a City. All theſe Species of Judging are peculiar to Men, and not enjoyed by Brutes in any degree.

ANOTHER Act of the Intellect, generally reduced to Judgment, is *Abſtraction*. This ſome ſuppoſe to be performed, by drawing the Mind off from all Ideas of Senſation, from all Compoſitions of them, and from all complex Notions, in order to form Ideas of incorporeal Beings: But it may be doubted, whether this be practicable, in our preſent State.

THE true Abſtraction ſeems to conſiſt, not in forming Ideas independent on Senſation, but in ſubſtituting the only Notions we have, which are natural, eaſy and familiar, to repreſent thoſe ſupernatural things, of which otherwiſe we can have no Notion: In transferring our thoughts from the literal Propriety of the Words by which we expreſs them, to that analogical Signification, whereby they are, as it were, ſpiritualized. This ſeems to be the only Abſtraction we are capable of, with regard to things Spiritual.

And this is ſo far from being independent on Senſation and the Operations of the Intellect, that we can no otherwiſe think or ſpeak of ſuch Objects, than in theſe worldly and human Symbols; and that if we abſtract from theſe, we abſtract from all Thought of Heavenly Beings, and can have neither Names nor Ideas for them.

WHAT has been hitherto ſaid of the Operations of the Intellect, relates only to Ideas of Senſation. Therefore 'tis proper to obſerve here, that the ſame Operations are likewiſe exerciſed, upon all our Alterations and Compoſitions of them. When the Memory is once furniſhed with thoſe voluntary Alterations and Combinations of ſimple Ideas, the Mind has the ſame full Power over Them, as over the Ground-work of them; namely, that of Simple Apprehenſion, and of Judgment in all its Branches: And the ſame arbitrary Sway it has over all the complex Notions and Conceptions, which are formed out of thoſe ſimple or complex Ideas, conſidered together with the Operations of the Intellect upon them.

BEFORE we cloſe this Head of Judgment, 'tis worth while to take particular notice, of that Species of one of its branches, Comparing, which is diſtinct from all the reſt, and is commonly called *Relation*. This is that Act of the Mind whereby it conſiders, the Dependencies of things on each other. I ſhall dwell on it no longer than is neceſſary to ſhew, the Procedure of the Underſtanding in attaining Knowledge.

FIRST, When we conſider the Relations of ſenſible Objects to each other, as they are in their own nature, without any reſpect which they bear to our Underſtanding, hence opens a ſpacious field of Knowledge: That of natural Cauſes and Effects, of the manner wherein natural things act upon, or ſuffer from, each other: In ſhort, of their influencing one another numberleſs ways: And this is Natural Philoſophy.

SECONDLY, From our Ideas of Senſation we infer the Exiſtence of thoſe outward Objects that occaſion them in us. And from the Exiſtence of theſe we infer a Firſt Cauſe of All things, Eternal and neceſſarily exiſting. Hence again we have the Knowledge of the Relation he bears to us, as our Creator and Preſerver. From theſe Relations flow all the Duties of Piety; ſuch as Love, Reverence, Praiſe and Prayer.

AGAIN. When we conſider the Relation we bear to our Fellow-Creatures, of the ſame Nature and Degree in this World, hence we come to be ſenſible of our Obligations to Juſtice and Humanity. And when we diſtinguiſh theſe by particular, nearer Relations, ſuch as Parent or Child, Servant or Maſter, hence we deduce all the Duties neceſſary to the well-being of the Whole Kind and of every Individual.

LASTLY, When we conſider the Relation we bear to ourſelves, the Regard every Man ought to have for his own Happineſs, hence we may infer all thoſe Duties that naturally tend, to promote the Good either of our Body or Mind. And all comprehended under this Second Head, is properly Natural Religion. For the Sanction of this, and to ſhew the tendency of its Precepts to our future Happineſs, the Underſtanding proceeds thus. From the unequal Diſtribution of Rewards to thoſe who obſerve them, and of Puniſhments to thoſe who tranſgreſs them in this Life, ſo evidently inconſiſtent with the Goodneſs and Juſtice of an all-perfect Being, we infer the Neceſſity of Future Rewards and Puniſhments, and conſequently the Immortality of Human Souls.

SECT. II.

Of the different Kinds of Knowledge and Evidence.

IT being a matter of the utmoſt conſequence to the right Procedure of the Intellect, to ſtate the ſeveral Kinds of Knowledge, as well as the Degrees of it in each

kind,

kind, which can admit of any: I ſhall obſerve, that there are Three Kinds of Knowledge, and as many Kinds of Evidence on which they are built.

THE Firſt is that we have from our Senſes, and conſiſts in an intellectual View of the Ideas tranſmitted thro' them to the Memory. This is a Knowledge Direct, immediate and intuitive, and carries in it the higheſt Certainty. Conſequently it admits of no Proof from Reaſon: for all ſuch Proof has leſs of Perſpicuity and Certainty, than that which it already contains in its own Nature. This is a Knowledge which admits of no Degrees of Evidence: For all Senſation is in itſelf equally certain, and the Evidence of all the Senſes is equally clear, with reſpect to their proper Objects. When the Senſation is regular and perfect, the Aſſent of the Intellect neceſſarily follows all at once; tho' in a Manner quite different from Demonſtration, which extorts it by intermediate Proof. Not that it yields to the cleareſt Demonſtration, when the Organ is rightly diſpoſed, and exerciſed upon its proper Object, at a juſt Diſtance and in a due Medium. Againſt Senſitive Knowledge Reaſon can never interpoſe, unleſs there is a Suſpicion of failure in the Act of Senſation. Nor does it enquire then, Whether the Evidence of Senſe be true? But whether it be truly the Evidence of Senſe? So that to argue againſt the Evidence of Senſe, is to oppoſe the Evidence of Reaſon, to what in its Nature admits of no Reaſoning at all.

AND highly neceſſary it was, that this Evidence of Senſe ſhould be ſo immediate, clear and undoubted, becauſe it is the Foundation of all Knowledge, Human and Divine. If then the truth of this admitted of any Doubt, or were capable of any Proof, we ſhould wander about in endleſs Scepticiſm, without the leaſt Certainty in any thing. For no Proof for it could be more evident, than that which it was brought to prove, and would therefore itſelf require another Proof; and ſo on, with endleſs Confuſion.

A SECOND Kind of Knowledge is that we have from Self-conſciouſneſs. We come to the Knowledge of things without us, by the mediation of their Ideas: but we are immediately conſcious of what paſſes in our own Minds, without the intervention of any Idea. Thus we have a Knowledge of all the Faculties of our Soul, very different from Senſitive Knowledge; tho' we have no degree of it antecedent to the Exerciſe of thoſe Faculties upon the Ideas of Senſation: As we ſhould have had no Knowledge of our Bodily Motions, if the Parts had not been actually moved.

THO' this kind of Knowledge be more complex, 'tis equally certain with that we have from Senſation. The Aſſent as neceſſarily follows upon Conſciouſneſs: Indeed it falls in with it. The Conſciouſneſs itſelf is the very Aſſent; nor can they be diſtinguiſhed even in thought. When this internal Senſation is truly Natural, we are never deceived in this article of Knowledge. And this alſo is ſo clear and diſtinct that it admits of no Proof from Reaſon. So that neither can this, any more than the former, be called *Demonſtration:* Since, like That, it is ſo immediate and intimate to us, that nothing can increaſe its Evidence: And for a man to *argue* away any Inſtances of this Knowledge, or to deny their Certainty, is no leſs abſurd than to contradict the clear Perceptions of External Senſe. Only it is to be obſerved, that all here ſaid of this Knowledge, is ſaid of the firſt, immediate, internal Perceptions: Not of any farther Obſervations, made upon them by the Intellect, or of any Deductions afterwards drawn concerning them.

THESE two kinds of Knowledge are immediate, and conſequently a ſort of Intuition: Entirely different from which is

THE Third kind of Knowledge, *Reaſoning*, which is mediate, and wholly acquired by Deduction, by the Exerciſe of that one Operation of the Mind, Illation or Conſequence. This we may ſubdivide into different Species, according to the different manner of the Intellect's procedure, in making its Deductions.

THE firſt Species is *Science* or *Demonſtration*, which appears cleareſt in the Syllogiſtic Form; by applying a common Meaſure to two Extremes, which have an *in-*

fallible Connexion with it. So that the Concluſion follows by an abſolute Certainty, and compels the Aſſent. And the Knowledge is as infallible as the direct, clear Perception of Senſation or Conſciouſneſs.

THE Second Species of it is Moral Certainty, the utmoſt Degree of which is neareſt to Demonſtration. This Knowledge is acquired by Proofs that have only an *undoubted* Connexion with the two Extremes. The force of this every plain Underſtanding perceives, and it rarely requires the Syllogiſtic Form, unleſs for the confuting perverſe Oppoſers. The Arguments for it are deduced from all kinds of Knowledge: But ſtill the Aſſent is free: And the Will has a great ſhare, in promoting or hindering it. And hence it comes, that there is room for Paſſion and Prejudice of all ſorts to interpoſe and bias the Intellect.

WE ought not therefore to call the Evidence of Moral Truths, by the Name of Demonſtration. It is true, both Mathematical and Moral Truths, are founded on the ſtrongeſt Proofs. Yet they admit not of the ſame Sort of Proof, nor indeed are they capable of it.

BECAUSE it is ſo great a diſadvantage both to Natural and Revealed Religion, to have Moral Certainty confounded with Mathematical, I ſhall diſtinguiſh the different Natures of them more fully, under two different Propoſitions.

Mathematical Certainty.	Moral Certainty.
As in this Propoſition, The three Angles of a right-lined Triangle are equal to Two Right ones.	As in this Propoſition, There is a GOD.
1. HERE there is the utmoſt degree of Mathematical Certainty: the Evidence is infallible, and the Conſequence follows by a Natural Neceſſity.	HERE there is the utmoſt degree of Moral Certainty: the Evidence is indubitable, and the Conſequence follows by a Moral Neceſſity.
2. THE Demonſtrative Evidence of this, when underſtood, compels and extorts Aſſent.	THE Moral Evidence of this, when underſtood, demands and requires Aſſent.

3. In this point of Knowledge, no Concurrence of the Will is requiſite. The Intellect aſſents without it, and no Prejudice or Paſſion can ſo interpoſe as to influence its Judgment.	In this point of Knowledge the Concurrence of the Will is requiſite. The Intellect cannot aſſent without it. Any Prejudice or Paſſion may ſo interpoſe as entirely to alter its Judgment.
4. This ſort of Knowledge admits of no Degrees of Certainty, and there can be no Proof of it, but of One Kind.	This ſort of Knowledge admits of many Degrees of Certainty, and draws its Proofs from all Kinds of Knowledge.
5. One Demonſtrative Argument makes the utmoſt Mathematical Certainty, which excludes all Poſſibility of Falſhood.	Many Arguments concur to make the utmoſt Moral Certainty, which excludes all Probability tho' not Poſſibility of Falſhood.
6. This takes place in things Natural and Material, ſuch as Quantity, Figure and Extenſion; Ideas of which we have from direct and immediate Senſation.	This takes place in things Supernatural and Spiritual, ſuch as God and his Attributes: of which we have no Idea from direct and immediate Senſation, but only from Analogy.
7. Our Reaſonings on this ſide are concerning Simple Ideas, concerning which there is a General Conſent.	Our Reaſonings on this ſide are about complex Notions and Conceptions, concerning which men extremely diſagree.

From the very different, and even oppoſite Nature of Moral Certainty, and that which is ſtrictly Mathematical, it muſt appear

1. That there is as little room for the latter in Natural Religion as in Revealed. To ſhew this clearly, I have inſtanced in the Fundamental Truth of Both: Which tho' founded upon the utmoſt Moral Evidence, ſo as to render a Diſſent from it inexcuſable, yet appears not to be ſtrictly Demonſtrable. Indeed were there one Demonſtrative Argument for it, all others would be entirely needleſs.

2. That Natural Religion includes Faith, founded on Moral Evidence. When upon full Proof to our Underſtanding, we aſſent to this, There is a God, then the hearty Concurrence of the Will, compleats that Aſſent into Faith. Faith therefore is altogether as neceſſary in Natural Religion as in Revealed. For tho' we have a Moral Certainty for the Exiſtence of a Deity, which ſo far is Knowledge only; Yet ſtill becauſe the intrinſic Nature of God is utterly incomprehenſible, and can be no immediate Object of Human Underſtanding, Men muſt give the Aſſent of the Intellect here, together with the Conſent of the Will, to the truth of things as myſterious, as any in all Revealed Religion; and which they are obliged to conceive by the ſame Analogy, by which we conceive all the Myſteries of Chriſtianity.

3. That Evangelical Faith is no precarious or implicit Aſſent, but founded on the utmoſt Evidence we are capable of receiving, for a Truth of that nature. To ſee this clearly, we muſt well diſtinguiſh two things:

First, the Aſſent of the Underſtanding to a Propoſition upon Moral Evidence, which is thus far merely Knowledge. Here we are to fix our foot and join iſſue with all ranks of Unbelievers: the ground of whoſe Condemnation will be, that they wilfully with-held their Aſſent from the Truths of Revelation, when they had the ſame Evidence, which would have fully convinced them, in Matters merely human.

Secondly, a Conſent of the Will, following the Aſſent of the Intellect. The whole Proceſs of the Mind in obtaining ſuch a Faith, is performed in this manner. Firſt, a Propoſition being offered to us, the Will conſents to weigh the Evidence for it: 2. The Intellect weighs it, and if the Moral Evidence be full, aſſents to it. Thus it commences a Point of Knowledge, and on a ſecond Conſent of the Will, a point of Faith.

But 'tis worth obſerving, that there can be no immediate Aſſent, to any thing inconceivable or incomprehenſible.

prehenſible. To explain this by a few Inſtances, "There is a God," When upon full Evidence we aſſent to this, what is intelligible in that Propoſition, is the immediate Object of our Knowledge. The incomprehenſible Nature and Attributes of God, are only the remote and mediate Objects of it.

Again. "This is my beloved Son." We aſſent to this as a perfectly intelligible Propoſition, on full Evidence that it was ſpoke from Heaven: Being aſſured that Chriſt, not in any unintelligible manner, but according to the plain Senſe of the Words, is as really and truly the Son of God, as one man is the Son of another.

He who believes thus far, without any reſpect to what is incomprehenſible in that Propoſition, namely the Supernatural Generation and the ineffable Manner of it, has an Evangelical Faith. But what then, you will ſay, becomes of the Myſteries of the Goſpel? They are all laid up ſafe, out of our reach, to be the immediate Objects of our Knowledge, when we come to ſee face to face.

From hence it appears, that Chriſtian Faith is not an implicit Aſſent to things unintelligible and unconceivable: Since nothing that is incomprehenſible can come into any queſtion between us and Unbelievers. We can have no controverſy, but about what is perfectly underſtood, as far as it is ſo: and concerning the Moral Evidence upon which Propoſitions as clear as any in Human Language are founded. Our Controverſies turn wholly upon what is clear. As to what is incomprehenſible in any Propoſition, it can be no immediate, direct Object, either of Knowledge or of Faith.

The Third Species of Knowledge, which we have from Reaſon, is *Opinion*, This *Plato* well defines A Medium between Knowledge and Ignorance. It is a ſort of Knowledge, looſely ſpeaking, inferior to any of the foregoing; but approaching neareſt to that founded on Moral Evidence. Only whereas Moral Certainty in its higheſt degree, leaves but a bare *Poſſi-*

bility of the things being otherwiſe: All Opinion leaves room more or leſs, for *Doubt*, yea for ſome Fear of its being otherwiſe. But as for all the Degrees, between the Higheſt Moral Certainty on one hand, and the loweſt Probability on the other, theſe two ſorts of Knowledge run into each other; and are not eaſily to be diſtinguiſhed,

THIS may be illuſtrated by a Parallel, drawn from common Mechaniſm. While you are offering the Reaſons, for and againſt any Morally-certain or Probable Propoſition, imagine yourſelf throwing them into the Scales, and weighing them in a ballance. If the Ballance inclines not at all to either ſide, there is no ſort of Knowledge, but downright *Ignorance*: The Reaſons on each ſide deſtroy each other, ſo that the Intellect cannot aſſent to either. And if there be any Deciſion, it is the arbitrary Impoſition and precarious Act of the Will. If either from its Natural Weakneſs, or for want of Improvement, the Intellect cannot find out Reaſons, ſo that each Scale preponderates in its turn, then it is a State of *Doubt*. If one Scale preponderates but a little, and continues at a ſtay, ſo that the Difference is barely diſcernible, it is then only a *Conjecture*. But if this preponderancy is very plain, tho' there is weight enough on the other ſide, to keep the Scale ſtill pendent, then it is properly *Probability* or *Opinion*. When laſtly, the Arguments are ſo ſtrong, that one of the Scales weighs to the ground, then it is *Moral Certainty*, and there is no reaſonable Cauſe for any farther Scrutiny. The Propoſition then concludes as *ſurely*, tho' not ſo *neceſſarily* as *Demonſtration*: Which admits of no Weight whatever to be thrown into the oppoſite Scale

OF Probability in general it may be obſerved,

1. THAT while we are weighing a Probable Propoſition, there are two latent Cauſes of Deceit: the one in the Intellect itſelf which holds the Ballance; for if a man is ignorant or weak, ſo as not to diſcern the proper Reaſons; he may be impoſed upon by falſe Weights: The other in the Will, when inſtead of

plain Reaſon, a man throws his Pride, or Paſſion, or Prejudice into the Scales. And theſe will by the inviſible turn of a falſe Ballance, outweigh the ſtrongeſt Arguments.

2. THAT the Higher Degrees of Probability, in matters of Religion, demand our Aſſent. So they do in all other things. Where the difference is not great between the oppoſite Sides of a Queſtion, men ever cloſe with the greateſt Appearance of Truth, and that in things of the greateſt moment. Nay the main Conduct of human Life, is governed by the higheſt Probality: So that in many Inſtances, it would be downright Madneſs, not to be determined by it. Yet

3. MERE Probability is not a ſufficient Ground for religious Faith. This muſt be built on certain Knowledge, which Opinion properly ſpeaking, is not. Indeed the word is vulgarly taken for any Aſſent whether formed on Probability or Moral Certainty. And ſo, 'tis commonly ſaid, "A Man is of ſuch an Opinion," with regard to the very Fundamentals of Chriſtianity. But this looſe way of ſpeaking ought never to be uſed, ſeeing it has a tendency to betray unwary men, into a favourable Judgment of ſuch Principles, as are deſtructive of all Religion.

THE Fourth Species of Knowledge which we have from Reaſoning, (if it be not rather a Particular Species of Moral Certainty) is An Aſſent upon *Teſtimony*: To make which truly Knowledge, there muſt be a concurrence of our own Reaſon in the following particulars:

1. OUR own Reaſon muſt judge of the Subject-matter of the Information, whether it be made in intelligible Words. For no man can be informed, of what he cannot underſtand: there can be no Revelation to us, concerning the intrinſic Nature of things, that are incomprehenſible to us. And accordingly no Part of the Chriſtian Revelation concerning GOD and things ſupernatural, reaches farther than their *Exiſtence*, and that lively Analogy under which they are repreſented, which

is as plain and obvious and intelligible, as any thing in common Life.

2. Our Reaſon muſt convince us, that the Matter of the Information is poſſible, that it implies no Contradiction. And if the Information relate to things ſupernatural, this is a fundamental Rule, To deduce no Contradiction but from what is plain and intelligible in every Propoſition: Whence it follows, that ſuch Abſurdities and Contradictions as ariſe, from a Compariſon of what is plain and intelligible, with what is incomprehenſible, in reſpect of their intrinſic Natures, are all groundleſs and imaginary.

3. Our Reaſon muſt judge concerning the Ability and Integrity of the Informer. Information or Teſtimony may be divided, into Human and Divine. To Human Teſtimony we aſſent only ſo far, as it appears agreeable to Truth. Yet this Aſſent is very extenſive, and makes up the greateſt Part of Human Knowledge. It takes in all we have of the Hiſtory of Mankind, all the Accounts of whatever we have not ſeen ourſelves. And we acquieſce in all this, not as probable only, but as ſo much real Knowledge: Being an Aſſent which is founded on ſuch Evidence, as often amounts to a Moral Certainty.

As to Divine Information or Revelation, Reaſon knowing it to be divine, is already convinced, that it exceeds all Human Certainty. The only thing therefore which it is to be conceived of here, is

4. That the Revelation is Divine; or, that the Scripture is of Divine Authority. In order to this we may obſerve

First, That as God has made Men the immediate Inſtruments of all thoſe Revelations, ſo Evangelical Faith muſt be partly founded on Human Teſtimony. By Men were both the Old and New Teſtament wrote; and if we conſider them abſtracted from their Divine Authority, they muſt be allowed to be of equal Credibility, at leaſt, with all other antient Writings. Tho' we ſhould ſuppoſe them to be upon the foot of mere Human Teſtimony, yet would our Knowledge of them be at leaſt of equal Certainty, with that founded on any profane

Hiſtory. Now if to this Human, we add ſuch Divine Teſtimony, as cannot be pretended for any other Writings in the world, as the Miracles of *Chriſt* and his Apoſtles; the concurrent Completion of all the Prophecies from the beginning of the World in Him alone; the Scriptures being the only Book in the world, that gives us any Account, of the whole Series of God's Diſpenſations toward Man from the Creation for four thouſand Years; the great Exaltation of Natural Religion, viſible in every Part of it, and laſtly the Providential Care, ſo manifeſt in every Age, for tranſmitting down ſeveral Books, written at ſuch great Diſtances of Time one from another, and all of them from Us; Their being at this day ſo void of any material Error, that in the infinite Various Readings, which have been carefully collected, there cannot be found One Contrariety in any fundamental Point of Faith or Practice. If theſe things, I ſay, are throughly conſidered, they give the Scriptures ſuch a Certainty, as no Writing merely Human can have, and are the greateſt Evidence for the Truth of them, which they are capable of receiving, without a continued, daily Repetition of Miracles. We may obſerve,

Secondly, That as God has made Men the immediate Inſtruments of all his Revelations, ſo he hath condeſcended to make uſe of Human Language, as well as of our Natural Ideas and Conceptions, for the clear and eaſy Repreſentation of things ſupernatural, and otherwiſe incomprehenſible. Indeed the intrinſic Nature of heavenly things, could no otherwiſe have been revealed to us; ſeeing we had neither Capacity to apprehend, nor Language to expreſs it. Or had it been miraculouſly revealed to a particular Man, yet it would not have been poſſible for him to utter it. This made it neceſſary to adopt all the Divine Revelations to our natural Way of thinking and ſpeaking. And accordingly we are not obliged to believe any Doctrine, which is not plain and intelligible. All in Scripture beyond this, is no immediate Object of our Faith, but belongs to another World: And we are at preſent to believe no more of it, than that it is incomprehenſible.

NOTHING therefore is more abſurd, than the Objections of Unbelievers againſt the Chriſtian Myſteries as unintelligible: Since Chriſtianity requires our Aſſent to nothing but what is plain and intelligible in every Propoſition. Let every man firſt have a full Conviction of the Truth of each Propoſition in the Goſpel, as far only as it is plain and intelligible, and let him believe as far as he underſtands. Let him firmly believe, There is but One GOD, the object of any Divine Worſhip whatever; and think and ſpeak of him under that plain Scriptural Diſtinction, of Father, Son, and Holy Ghoſt: Leaving the incomprehenſible Nature of that Union and Diſtinction, to the great Author of our Faith himſelf. Let him believe *Chriſt* to be the only-begotten Son of GOD, in the obvious Import of thoſe words, and leave the Manner of that inconceivable Generation, to the Veracity of GOD. Let him believe, that *Chriſt* did as truly make an Atonement to GOD for Us, as one man atones for another to a Third Perſon; and leave the unintelligible Part of that divine Operation, for the Subject of future Praiſe and Contemplation. Let men, I ſay, believe as far as they thus clearly underſtand, without perplexing themſelves or others with what is incomprehenſible; and then they fulfil the whole Purpoſe of GOD in all his Revelations.

BY thus carefully diſtinguiſhing the ſeveral kinds of Knowledge and Evidence, what endleſs Confuſion may be prevented, in Religious Controverſies? Moſt of theſe have ariſen, from ſuppoſing theſe Heads of Knowledge to differ in Degree only, not in Kind; and from confounding the different Kinds of Evidence, peculiar to each of them: From men's inſiſting upon the Evidence proper to one kind of Knowledge, for that of another, which will not admit of it: From oppoſing to each other the different Kinds of Knowledge, which can never interfere or claſh with each other: And, laſtly, from not diſtinguiſhing between a blind, implicit Aſſent to the Teſtimony of Another, and that Faith, which implies a full, rational Conviction of the Truth of what is believed.

SECT.

SECT. III.

Of the Improvement of Knowledge by Revelation.

WE have now brought the Mind of Man by ſeveral Steps to the utmoſt Knowledge it can reach by its own Faculties. Whatever is beyond That contained under the foregoing Heads, is communicated to it from Heaven.

WHEN we obſerve, 1. The more particular and full Diſcoveries, of thoſe Relations we had ſome knowledge of by the Light of Nature, * and 2. Thoſe Relations we bear to GOD and GOD to Us, which are intirely new, and undiſcoverable by the Light of Nature: This Knowledge includes the Foundation and Subſtance of all Revealed Religion.

As to the Firſt, When to that General Knowledge we have by the Light of Nature, of GOD as the Creator of all things, it is revealed, That he *ſpoke them* into being, and created them *by his Word*; that he made Man in particular *out of the earth*, and breathed into him a Principle of an higher kind: That he was created in Innocence and *in the image of GOD*, and that from Him all Mankind deſcended.

AGAIN. When to the General Relation of his Providence over us, it is more particularly revealed, That he *upholdeth all things by the word of his power*; that *in him we live, move and have our being*; that *not a ſparrow falls to the ground without him*, nay, that *the hairs of our head are all numbered*: And, laſtly, when his Relation to us as a Judge is rendered more full and expreſs by theſe Particulars, That *the eyes of the* LORD *are in every place*,

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* I BELIEVE all "the Light of Nature," ſo called, to flow from Preventing Grace.

place, beholding the evil and the good; that *he ſhall bring every work into judgment, with every ſecret thing, whether it be good or evil*; that *he hath appointed a day in which he will judge the world*, and that in order to this univerſal Judgment there ſhall be a Reſurrection of the dead, both of the juſt and of the unjuſt.

AGAIN, when it is revealed, that *there is but one* GOD in oppoſition to the multitude of Heathen Deities; that this GOD *is a Spirit*, that *there is none Good but* He, that He *only is wiſe*, and his Wiſdom is infinite, that he is Almighty, hath all Power, is *above all, the only Potentate, King of Kings* and *Lord of Lords*; that he is *the moſt high, the Lord of Hoſts*, who *only hath immortality*: Theſe and ſuch like equally-expreſs Declarations, concerning the One GOD, are evident Improvements, of that Knowledge, which we have by the light of Nature.

THESE Expreſſions are all plain and intelligible, ſo that when we uſe them, we know what we ſay. But as to the following Expreſſions concerning the One GOD, That he is "GOD of himſelf, Root, Principle, Original"; That he is a "Pure Act, Simple, undivided, Self-exiſtent, abſolutely-ſupreme:" Together with the words "Subordinate, Co-ordinate," and above all, his Metaphyſical "Subſtance and Eſſence": Theſe are not the Language of Revelation, eſpecially when uſed to explain the Unity of GOD; but affected Terms invented by Men, to expreſs their ſeveral Sentiments of that Unity.

CAN we ſufficiently lament, the Miſchief which has been done by the rumbling of theſe and ſuch like ſounding words thro' whole Volumes? To the confounding both the Writer and the Reader, and perplexing that great Article of our Faith, the Trinity: Which as it lies in the Scripture, is ſo far as we are to believe it, the plainneſt thing in the world? All this pompous Affectation of being more knowing in the Chriſtian Myſteries, than the Scriptures can make men, tends only to propagate abſurd and inconſiſtent Notions, which a plain rational Man would be aſhamed of. Such as theſe, That the Son of God was produced by an external Act of the Father's Power, but was not made or created.

That there are three Perſons truly Divine: One of them the true God, the Second, Truly God, the Third, no God at all.

That we may and muſt pay Divine Worſhip to two Gods, and Divine Honour to a third Perſon, who is no GOD:

That by the term *Trinity* we muſt mean, A trinity of Two Gods, and a Divine Perſon, but no God.

These and many ſuch Poſitions are either expreſly or by plain conſequence contained in ſome of our modern Syſtems of Religion, and are ſet down here, not as they are a total Subverſion of the Chriſtian Faith, but as they are a bold and arbitrary Impoſition upon the Common Senſe and Reaſon of Mankind.

The Relation we bear to God as our Creator, which was partly diſcovered by the Light of Nature, is made nearer yet, and more dear and engaging, by that entirely-new Diſtinction in the One God, revealed to us under the different Characters of Father, Son and Holy Ghoſt, and by the unſpeakable Bleſſings we derive, from their Several Offices and Operations.

This Diſtinction, utterly incomprehenſible in itſelf, could never have been known to Men, but by Revelation. Nor could we have conceived it in any degree had it not been diſcovered to us, under the Semblance of ſuch Relations, as are familiar among men: As that of a Father and a Son, and the Spirit of a man which is in him. And if we admit this Diſtinction at all, we muſt hold it to be ſo really founded in the Divine Nature, that we cannot think or ſpeak of itſelf any otherwiſe than as a perſonal Diſtinction. For the Father, Son and Holy Ghoſt, are in reſpect of one another, thus diſtinguiſh'd thro' the whole Language of Revelation: And in reſpect of Mankind, they are ever diſtinguiſhed by ſuch different Operations, as we diſtinguiſh Human Perſons by. So that whatever is denoted

noted by Father, Son and Spirit, we muſt either flatly reject the Scriptures, or elſe always ſpeak and think of thoſe Three, as we do of three Human Perſons.

THAT Chriſt, the Second Perſon, had a Being, before he was born of a Virgin, is ſo evident from Revelation, that we can make no Senſe or Coherence of Scripture, without allowing it: And there can be no other purpoſe, in revealing all things concerning him, under the Character of a Son, and only begotten Son, but to convince us, that he has all the Natural, Eſſential Attributes of his Father: that as an Human Son poſſeſſes the entire, human Nature, ſo the Son of GOD poſſeſſes the entire Divine Nature.

THAT the Holy Spirit, who is in Scripture diſtinguiſhed from the Father and the Son, is a diſtinct Perſon from both, is plain from the Commiſſion given the Apoſtles to baptize, *in the name of the Father and of the Son and of the Holy Ghoſt:* This Form, if each of theſe be not a diſtinct Perſon, ſufficiently tends to confound Mankind. If the Holy Ghoſt be not a diſtinct Perſon, but only a Power of the Father, then the Senſe of it runs thus, "Go and baptize in the name of the Father, and of the Son, and of the Father again." Therefore to ſay the Third Perſon here mentioned, is a mere Name, and imports only the Power of the Father, is not only charging GOD with laying a Snare to deceive us, but denying his Commiſſion to be Common Senſe.

THAT the Holy Spirit is GOD, is evident from Revelation, which every where diſtinguiſhes him by this peculiar Character of Holy. For abſolute Holineſs is the peculiar Attribute of the abſolutely-Supreme GOD: And He being every where called, "The Holy Spirit," by way of Excellency, and Diſtinction from all Created Spirits, That Epithet muſt imply an Original, intrinſic and eſſential Holineſs in Him. Eſpecially if we obſerve, That this is his conſtant, diſtinguiſhing Character, not only where he is mentioned

oned with relation to Us, but alſo where he is named, together with the Father and the Son. Inſomuch that He alone is expreſly ſtiled Holy, wherever the Three Perſons are expreſly named together in Scripture.

The word *Holy* in thoſe places cannot be added, in oppoſition to the Father and the Son: Nor as excluſive of them; becauſe they are both, abſolutely Holy, as well as the Spirit: So that they naturally lead us into a belief, That His is the ſame Holineſs with that of the Father and the Son, namely, the intrinſic Holineſs of Jehovah, the moſt high, the Supreme God. To this if we add, That he is called, "*The Spirit of Holineſs, the Spirit of Glory, the eternal Spirit*, and very often *the Spirit of* God, as particularly at the Baptiſm of Chriſt, where he was perſonally diſtinguiſhed from the Father, even in a viſible Appearance: We muſt have our Reaſon ſtrangely amuſed by Subtilty and Criticiſm, and be turned quite out of the plain Way of Thinking, before we can underſtand theſe Revelations, to mean any thing elſe, than that He is God, equal with the Father.

The Sum is this. Since both Reaſon and Revelation ſhew, there is but one God, we can own and worſhip but One. And ſince that One God is ſet forth to us in Scripture, under Three diſtinct Relations, and accordingly repreſented by diſtinct Perſonal Names, and Characters and Operations and Offices: Therefore we worſhip but One God with this Diſtinction of his own making, not of Ours.

It is ſaid, *Thou ſhalt worſhip the Lord thy* God, *and him only ſhalt thou ſerve*: by which All Divine Worſhip is utterly cut off from the Son and Holy Ghoſt, unleſs they are One with the Lord our God. Again, it is written, *The* Lord *thy* God *is One* Lord, whom we are to *love with all our heart, mind, ſoul, and ſtrength*. But if ſo, All Divine Love is cut off from the Son and Holy Ghoſt, unleſs they are that One Lord our God: Who is a jealous God, and will by no means ſuffer any Part of his Worſhip to be paid to any other.

ACCORDING to this plain and natural way of thinking, as we are baptized by one and the ſame ſolemn Act of Worſhip, *In the name of the Father, and of the Son, and of the Holy Ghoſt:* So we ever after adore them, without any Degrees or Inequality of Worſhip: Which indeed, as it is truly Divine, can admit of no Degrees or Inequality. Whereas they who argue for an Inequality in the Divine Perſons, and for an Inferiority of Nature in the Son and Holy Ghoſt to the Father, neceſſarily involve themſelves and all their Adherents in endleſs Uncertainty and Confuſion. For they can never ſettle the different Kinds and Degrees of that *Lower Divine Worſhip*, (a Contradiction in the very Terms) which is to be paid to the Son and the Holy Ghoſt. They can never diſtinguiſh it with ſuch Exactneſs, that it ſhall neither be the Worſhip due to the Supreme GOD, nor that Honour which is to be paid to mere Creatures, and varied according to their ſeveral Dignities.

BUT to make it yet more clear, That the Mind of Man cannot without Abſurdity, have any other Conception of the Son and Holy Ghoſt, than as being incomprehenſible, One abſolutely ſupreme GOD with the Father, and One joint Object of all Chriſtian Worſhip, let us collect the Two ſeemingly-inconſiſtent Doctrines, into Oppoſite Propoſitions.

THERE is no other GOD but One. THOU ſhalt worſhip the LORD thy GOD, and him only ſhalt thou ſerve.	LET all the Angels of GOD worſhip Him. BAPTIZE all Nations in the Name of the Father, and of the Son, and of the Holy Ghoſt.
ON this ſide the Precepts are expreſs and poſitive, for our believing in One GOD alone, and for paying Divine Worſhip to him only. They are full and peremptory againſt addreſſing ourſelves religiouſly to any other	ON this ſide the Precepts are equally expreſs and poſitive for our believing the Son and the Holy Ghoſt to be GOD, and for the whole intelligent Creation to pay Divine Worſhip to the Son in particular. They are likewiſe

other than that One Supreme God, who is a jealous God, and will not ſuffer any Degree of Divine Worſhip to be directed to any other. Nor can we frame any other Notion of Idolatry, than the addreſſing ourſelves either in Body or Mind, by way of Religious Worſhip to any other Being than to the Supreme God.

likewiſe full and peremptory for our addreſſing ourſelves in one of the moſt ſolemn Acts of Divine Worſhip, jointly to the Father, Son and Holy Ghoſt. And as we are initiated into Chriſtianity by this Act, ſo we are ever after bleſſed in the name of the Three jointly: And all this, without the leaſt direct or indirect Mention or Intimation of any Inequality in their Natures, or of any Diſtinction in their Worſhip.

Now both theſe Precepts are expreſs Scripture, and therefore equally objects of our Faith, It being evident, that here is no Contradiction in terms, and that the ſeeming Contradiction is with regard to a Unity and Diſtinction, for the direct Apprehenſion of which, there is no Capacity in the Mind of Man; the Wiſdom of God has left it for us to believe them both, and to reconcile them according to the beſt of our Underſtanding: Not by taking upon us to ſhew, How the Divine Nature is One, and how it is Three: but by ſolving the ſeeming Oppoſition in a way moſt obvious to a plain Capacity. That is, by concluding, Since there is but One God, who alone is to be worſhipped, and ſince the Son and Holy Ghoſt are both called God in Scripture, and expreſly commanded to be worſhipped; therefore they are One with the moſt high God, tho' how they are One we cannot comprehend.

Thus has the Goſpel-Revelation improved the Knowledge of Mankind, in theſe important Points. And it has no leſs improved our Knowledge, in the grand Article of Future Rewards and Puniſhments.

As to Rewards, 1. Whereas all that was before expected in the other World, was Senſual Pleaſures for the Body, and pleaſing Contemplation for the Soul: Now we learn the Joys of Heaven to be of a ſort, whereof Nature can give us no Conception: We ſhall be as the Angels of God in Heaven.

2. The Reſurrection of the ſame Body, is a point intirely New, of which Chriſt's riſing with the ſame Body aſſures us. That this Body will be *changed*, is likewiſe intirely New: That this Change ſhall be effected in a moment: that the Dead in Chriſt ſhall riſe firſt: that their Change ſhall be into the likeneſs of Chriſt's glorious Body: All which particulars are beyond whatever could have been ſuggeſted, by the mere Underſtanding of man.

Another Inſtance of Revelation intirely new with reſpect to theſe Rewards is, That of living for ever in the immediate Preſence of God, the Fountain of all Happineſs. We are now informed, That we *ſhall ſee* God *as he is, face to face, in whoſe preſence is fulneſs of Joy:* That we *ſhall be where he is*, ſhall *behold his Glory*, and ſhall ſhine forth as the ſun in the kingdom of our Father. This is a ſtrain no Imagination merely human could ever reach or aſpire to. We may add, that whatever the wiſeſt Heathens ſpoke of future Rewards, was only from faint Conjecture: Whereas now we have the plain and expreſs and repeated Promiſe of God for them.

As to Future Puniſhments we learn from Revelation alone,

1. That they are both for Soul and Body, which are diſtinguiſht by *the worm that dieth not*, and *the fire that is not quenched*. And accordingly we are bid to *fear him who is able to deſtroy both body and ſoul in hell.*

2. That the Soul will be *puniſhed with everlaſting Deſtruction from the preſence of the Lord*. That the chief of all Miſery in another Life, would be excluſion from the ſight of God, was never thought of by the wiſeſt Heathens, who placed all Happineſs in themſelves.

3. That the Body will be puniſhed by Fire, than which we have not any Revelation more expreſs and

poſitive. And as it is an inſtance of the great Goodneſs of God, that the Joys of Heaven are repreſented figuratively, as exceeding the utmoſt of our Conceptions; ſo it is an Argument of his ſtrict Juſtice, that the Pains of Hell are more literally foretold.

4. The Eternity of theſe puniſhments is revealed, as Plainly as Words can expreſs it. Not that the Puniſhments denounced, are mere arbitrary Sanctions, like thoſe annext to Human Laws. But thoſe Denunciations are withal ſo many previous Warnings, of the inevitable Conſequence, the Natural Tendency of Sin to Miſery. So that an unrepenting Sinner cannot be otherwiſe than miſerable in another Life by a Neceſſity of nature: Since there never can be any Alteration of his condition, without ſuch a Change of the whole Man, as would put the natural and ſettled Order of the Creation out of courſe.

With reſpect to theſe Rewards and Puniſhments, we have theſe farther Revelations: That the very *Day* is *appointed* by God, *in which he will judge the World in righteouſneſs, by the Man whom he hath ordained*; That he hath committed all judgment to the Son; and that all Mankind muſt come upon their trial at once. The glorious Pomp and Majeſty of his Appearance, the awfull Solemnity of the whole Procedure, nay the very Words of the Sentence both on the Juſt and on the Unjuſt are diſcovered to us. It is farther revealed, That in this Day of God, while he deſcendeth with ten thouſands of his Angels, *the heavens being on fire, ſhall be diſſolved, and the elements ſhall melt with fervent heat*. Theſe are *the terrors of the Lord*, which are ſufficient to make the ſtout-hearted tremble, and are ſuch Motives to all Holineſs of Heart and Holineſs of Converſation, as nothing but Infidelity or wilful Want of Conſideration, can render ineffectual.

Having now as my Leiſure and Abilities permitted, taken a Survey of the Wiſdom of God in the Creation: before I conclude, it may not be improper to add ſomething,

thing, in anſwer to thoſe on the one hand, who imagine all Enquires of this kind to be vain, fruitleſs Labour, and thoſe on the other, who ſpend more Time therein, than is conſiſtent either with Religion or Reaſon.

I do this chiefly in the words of that great Ornament of his Profeſſion, the Lord Chief Juſtice *Hale*. He ſuppoſes *the Good Steward*, giving in his Account at the Laſt Day, thus to ſpeak. (Happy is He, who can adopt his Words, in ſpeaking to the Judge of All!)

1. I have not looked upon thy Works inconſiderately, and paſſed them over as ordinary things: But I have ſtudiouſly and diligently ſearched into them, as things of great Eminence and Wonder; and have eſteemed it Part of the Duty, which the wiſe God of Nature requires of the Children of men, who for that very end expoſed theſe his Works, to the view of his intelligent Creatures, and gave us not only Eyes to behold, but Reaſon, in ſome meaſure to underſtand them. Therefore I have ſtrictly obſerved the Frame of the World, and its ſeveral Parts, the Motion, Order and Divine Œconomy of them. I have ſearched into their Quality, Cauſes and Operations, and have diſcovered as great, if not greater matter of Admiration than in the Beauty which at the firſt View they preſented to my Senſe.

2. And this Obſervation did not reſt in the bare Peruſal of the Works themſelves, or in the ſearching out, ſo far as that could be done, their immediate natural Cauſes. But I traced their Being, Dependence and Government unto Thee, the Firſt Cauſe of All. And by this tracing of things to their Original, I was led to a demonſtrative Conviction, that there is a God, who is the Great Cauſe, both of their Being and Motions: Yea, that there is but One God; that he is moſt powerful, moſt wiſe, knowing all things, governing all things, ſupporting all things. Upon theſe Convictions I was ſtrengthened in the belief of thy holy Word, which had ſo great a Congruity with theſe Truths

3. And upon theſe Convictions I did learn the more to honour, reverence and admire Thee, and to worſhip, ſerve and obey Thee, to walk humbly and ſincerely and

lawfully before Thee, as being preſent with me, and beholding me, to love and adore Thee, as the Fountain of all Being and Good. When I looked upon the Glory and Uſefulneſs of the Sun, I admired the God that made it, chalked out its Motions, placed it in that due Diſtance from the Earth, for its Uſe and Conveniency. When I looked upon the Stars, thoſe huge and wonderful Balls of Light, placed at that immenſe Diſtance from the inferior Bodies, and one from another, their Multitude and Motion, I admired the Wiſdom and Power of that God, whoſe Hand ſpans the Heavens, and has fixed every thing in its place. Nay, when I looked upon the poor, little Herbs, that ariſe out of the Earth, and conſidered the ſecret Spark of Life, which is in every one of them, that attracts, increaſeth, groweth, produces Seed, preſerves them and their Kinds; the various Virtues that are in them, for the Food, Medicine and Delight of the more perfect Creatures: My Mind was ſweetly carried up, to the Adoration and Praiſe of that God, whoſe Wiſdom and Power and Influence and Government, are ſeen in theſe Footſteps of his Goodneſs. So that take all the wiſeſt and ableſt Men, the moſt powerful and the moſt knowing under Heaven, they cannot all equal the Wiſdom and Power that are ſeen in a Blade of Graſs. Nay, they cannot ſo much as trace out, or clearly and diſtinctly decypher, the great Varieties in the Production, Growth and Proceſs, of its ſhort yet wonderful Continuance. Inſomuch that there is ſcarce any thing upon Earth, be it ever ſo inconſiderable, but yields me Inſcriptions of the Power and Wiſdom of its Maker written upon it.

4. In the contemplation of thy great Works of the Heavens, thoſe goodly, beautiful and numerous Bodies, ſo full of Glory and Light, I could not but make that natural Reflection, Lord, *what is man, that thou art mindful of Him, or the Son of man, that thou regardeſt him?* It is true, Man conſidered in himſelf, is a Creature full of wonder: but compared with theſe goodly Creatures, he ſeems but an inconſiderable thing. I learned hereby, to be humbled to the Duſt, and to

adore thy Condeſcenſion, that thou art pleaſed from Heaven, the Dwelling-place of thy Majeſty, to take care of ſuch a Worm as Man, ſinful Man!

5. In the contemplating thy Power and Wiſdom, in creating and governing the World, I have learned Submiſſion to thy Will, as being the Will of that moſt wiſe God, that by his Wiſdom not only created at firſt, but ſtill governs all things. I have learned to depend upon thy Providence, who tho' I am but a worm in compariſon of thy Heavenly Works, yet am an excellent Creature in compariſon of the Ravens, and the Herbs of the field. Yet thoſe he feeds, and theſe he cloaths: And ſhall he not much more cloath and feed *me?* Thus I have in ſome meaſure improved the Talent of thy Works, to trace out thy Majeſty and my own Duty.

Now is it a vain or fruitleſs Labour, thus to ſurvey the wonderful Works of God? And yet it is certain, we may run to exceſs, even in Enquiries of this nature. We may ſpend far more Time and Pains therein, than is conſiſtent either with Religion or Reaſon. Have we not a curious Inſtance of this, in the Writings of a late eminent Philoſopher? At the ſame time, a Divine by Profeſſion, and Rector of a conſiderable Pariſh. "During the whole time, ſays he, that I have reſided here, I have not been able by all my Induſtry, to diſcover any more than fifty-three Species [of Butterflies!] in this Neighbourhood. But I verily believe, if God ſpares my Life a few years longer, I ſhall be able to find ſeveral more!" Was it not pity, but his Life ſhould have been ſpared fifty Years, for ſo excellent a purpoſe?

To thoſe who lean to this Extreme, I would recommend a few more Reflections, extracted from the ſame maſterly Writer.

1. My Learning of Natural Cauſes and Effects, and of Arts and Sciences, I have not eſteemed to be the chief or beſt Furniture of my Mind, but have accounted them droſs in compariſon of the Knowledge of Thee and thy Chriſt, and him crucified. In acquiring them, I have always taken care, 1. That I might not too prodigally

beſtow my time upon them, to the prejudice of that time and pains which was moſt profitably beſtowed, on the acquiring of more excellent Knowledge, and the greater Concernments of my everlaſting Happineſs.

2. I CARRIED along with me in all my Studies of this kind, the great Deſign of improving them and the Knowledge acquired by them, to the Honour of thy Name, and the greater Diſcovery of thy Wiſdom, Power, and Truth; and ſo tranſlated my ſecular Learning, into an Improvement of Divine Knowledge. And had I not ever preſerved that Deſign, in my Acquirement of Natural Knowledge, I ſhould have accounted all the time miſ-ſpent, which had been employed therein. For I ever thought it unworthy of a man, who had an everlaſting Soul, to furniſh it with ſuch Learning as either would die with the Body, and ſo become unuſeful for his everlaſting State, or that in the next moment after Death, would be attained without Labour.

3. MY Knowledge did not heighten my Opinion of myſelf: For the more I knew, the more I knew my own Ignorance. I was more and more convinced, That I was very ignorant, even in what I thought I knew. And I found an infinite Latitude of things, which I did not know at all. Yea, the farther I waded into Knowledge, the deeper ſtill I found it. And it was with me juſt as it is with a Child, that thinks, if he could but come to ſuch a Field, or climb to the Top of ſuch a Hill, he ſhould be able to touch the Sky. But no ſooner is he come thither, than he finds it as far off as it was before. Juſt ſo, while my Mind was purſuing Knowledge, I found the Object ſtill as far before me as it was, if not much farther, and could no more attain the full and exact Knowledge, of any one Subject, than the hinder Wheel of a Chariot can overtake the former. Tho' I knew much that others were ignorant of, yet ſtill I found there was much more, whereof I was ignorant than what I knew, even in the compaſs of the moſt inconſiderable Subject. And as my very Knowledge taught me Humility, in the Senſe of my own Ignorance, ſo it taught me the Narrowneſs of my Underſtanding, which

could take in things only by little and little. It taught me, That thy Wiſdom was unſearchable, and paſt finding out: Yea, and that thy Works, tho' they are but finite in themſelves, and neceſſarily ſhort of the infinite Wiſdom that contrived them, are yet ſo wonderful as fully to confirm the Obſervation of the wiſe man, *No man can find out the Work that thou makeſt, from the beginning to the End.* If a man were to ſpend his whole Life, in the ſtudy of a poor Fly, he would ſtill leave much more undiſcovered, than the moſt ſingular Wit ever attained.

4. It taught me alſo, with the wiſe man, (when I looked back on what I had attained) to write Vanity and Vexation, upon all my ſecular Knowledge and Learning. That little I knew was not attained without much Labour, nor yet free from much Uncertainty. And the great Remainder, which I knew not, rendered that I knew poor and inconſiderable.

5. Hence I did moſt evidently conclude, That the Perfection of my Underſtanding, was not to be found, as neither my Happineſs, in this kind of Knowledge: In a Knowledge thus ſenſibly mixt with Ignorance, in the things I ſeemed to know, mingled with pain and diſſatisfaction, in reſpect of the things I knew not. And the more I knew, the more impatient my Mind was, to know what it knew not. My Knowledge did rather inlarge my Deſire of knowing than ſatisfy it. The moſt intemperate ſenſual Appetite, was more capable of being ſatisfied by what it enjoyed, than my Intellectual Appetite was, of being ſatisfied with the things I knew. The inlarging my Underſtanding with Knowledge, did but inlarge the Deſire I had to know. So that the Anſwer which was returned to *Job*, upon his Inquiſition after Wiſdom, *The depth ſaith, it is not in me, and the ſea ſaith, it is not in me:* the ſame account all my ſeveral kinds of Knowledge gave, when I enquired for Satisfaction in them. My Metaphyſics, when I had peruſed great Volumes of it, it was ſo Mercurial, I could hardly hold it: And yet ſo endleſs, that the more I read or thought of it, the more I might. Natural Philoſophy,

almoſt in every Branch, was full of Uncertainty. Much of it was grounded on Suppoſitions impoſſible to be experimented. The latter Philoſophers cenſured the former, and departed from them. The lateſt deſpiſed and rejected both, as equally ignorant. The Subject to be treated of was as vaſt, as the viſible or tangible Univerſe. And yet every individual thing was ſo complicated, that if all the reſt were omitted, this alone had more Lines concentered in it, than any one Age could ſift to the bottom. Yet any one loſt, or not exactly ſcanned, left all the reſt precarious and uncertain. And what could we expect to know, while we know not ourſelves, not even our own Bodies? Yet none could ever do this: the Diſquiſition concerning any one Part of the Human Body, the Brain, the Eye, the Blood, the Nerves, utterly perplexed the moſt exact Scrutators. But ſuppoſe it were otherwiſe: Suppoſe we could attain a full Knowledge of Philoſophy, that we could maſter every branch thereof, yet three Unhappineſſes attend it:

First, That moſt Parts of it are of little Uſe; they are only known, that they may be known. That which is of ordinary Uſe is ſoon attained, and by ordinary Capacities: The reſt were little better than laborious Trifles, curious Impertinencies:

Secondly, That they ſerve only for this Life: A ſeparated Soul or a ſpiritualized Body will not be concerned in them.

But admit they ſhould, yet Thirdly, a greater Meaſure of ſuch Knowledge will be attained, in one Hour after our Diſſolution, than the toilſome Expence of an Age in this Life would produce. What a deal of pains is taken here, concerning the Motion of the Sun or Earth: Concerning the Habitableneſs of the Moon, and other Primary or Secondary Planets: Concerning the Nature, the Magnitude and the Diſtance of the Fixt Stars: Concerning the various Influences of the Heavenly Bodies, in their Oppoſitions, Conjunctions, Aſpects? When once the immortal has taken its flight, thro' the Stories of the Heavens, in one moment all theſe will be known diſtinctly and evidently. All our Doubts will be reſolved, and our Souls filled with Light, without any mixture of Darkneſs.

Upon all theſe Conſiderations I concluded, that my Intellectual Power, and the Exerciſe of it in this Life, was given for a certain, uſeful and becoming Object, even to *know thee, the only true* God, *and* Jesus Christ *whom thou haſt ſent.*

In many Parts of the preceeding Tract, I have occaſionally touched on the Littleneſs of Human Knowledge. Perhaps a few more Obſervations on this important Head may not be unacceptable to the ſerious Reader. I propoſe them barely as Hints, which may be perſued at large, by men of Reflection and leiſure.

To begin (where we ended before) with the things which are at the greateſt Diſtance from us. How far does the Univerſe extend, and where are the *Limits* of it? Where did the Creator "ſtay his rapid Wheels?" Where "fix the golden Compaſſes?" Certainly Himſelf alone is without Bounds, but all his Works are finite. Therefore he muſt have ſaid at ſome point of Space,

> "Be theſe thy Bounds:
> This be thy juſt Circumference, O World!"

But where, who can tell? Only *the Morning-Stars* who then *ſang together, the Sons of* God, who then *ſhouted for joy*. All beyond the Region of the Fixt Stars, is utterly hid from the Children of men.

And what do we know of the *Fixt Stars?* A great deal, one would imagine: Since, like the moſt High, we too *tell* their *number*, yea, and *call them all by their names!* Thoſe at leaſt which appear to the naked eye, both in the Northern and Southern Hemiſphere. But what are theſe in compariſon of thoſe which our Glaſſes diſcover, even in an inconſiderable Part of the Firmament? What are one or two and twenty hundred, to thoſe which we diſcover in the *Milky-way* alone? How many are there then in the whole Expanſe, in the boundleſs Field of Ether? But to what *End* do they ſerve? To illuminate Worlds? To impart Light and Heat to their ſeveral Choirs of Planets? Or (as the ingenious Mr. *Hutchinſon* ſuppoſes) to gild the Extremities of the ſolar Sphere, which according to Him is the only inhabited Part of the Univerſe: And to miniſter, in ſome unknown way, to the perpetual Circulation of Light and Spirit?

FOR our ſakes only that great Man apprehends the *Comets* alſo to run their amazing Circuits! But what are Comets? Planets not fully formed? Or Planets deſtroyed by a Conflagration? Or Bodies of an wholly different Nature, of which therefore we can form no Idea? How eaſy is it to form a thouſand Conjectures: how hard to determine any thing concerning them? Can their huge *Revolutions* be even tolerably accounted for, by the Principles of Gravitation and Projection? Has not Dr. *Rogers* overturned the very foundation of this faſhionable Hypotheſis? What then brings them back, when they have travelled ſo immenſely far beyond the Sphere of the Solar Attraction? And what whirls them alone, when by the Laws of Gravitation, they ſhould immediately drop into the Solar Fire?

WHAT is the *Sun* itſelf? It is undoubtedly the moſt glorious of all the inanimate Creatures. And its *Uſe* we know. GOD made it *to rule the Day*. It is

" Of this great World both Eye and Soul."

But who knows of what *Subſtance* it is compoſed? Or even, whether it be fluid or ſolid? What are thoſe on his Surface that are continually changing? What are thoſe that always appear in the ſame place? What is its real Magnitude? Which ſhall we embrace, amidſt the immenſe Variety of Opinions? Mr. *Whiſton* indeed ſays, That eminent Aſtronomers are nearly agreed upon this Head. But they cannot agree concerning his Magnitude, 'till they agree concerning his *Diſtance*. And how far are they from this. The Generality of them believe, that he is near an hundred Millions of miles from the Earth. Others ſuppoſe it to be Twenty, ſome Twelve Millions: And laſt comes Dr. *Rogers*, and brings a clear and full *Demonſtration*, ſo he terms it, That they are not Three Millions from each other. What an unbounded Field for *Conjecture* is here? But what Foundation for real *Knowledge*?

Just as much do we know of the feebly-ſhining Bodies that move regularly round the Sun: Of *Jupiter*, *Saturn*, and the other *Planets*. Their *Revolutions* we are acquainted with. But who is able to this day, regularly to demonſtrate, either their *Magnitude* or their *Diſtance?* Unleſs he will prove, as is the uſual way, the Magnitude from the Diſtance, and the Diſtance from the Magnitude! And what are *Jupiter's Belts?* Can any man tell? What is Saturn's *Ring?* The honeſt Plough-man knows as well as the deepeſt Philoſopher. How many *Satellits*, *Secondary Planets*, move round Jupiter or Saturn? Are we ſure even of their Number? How much leſs of their Nature, Size, Motions, or Diſtances round the Primary? But what wonder we are ſo ignorant concerning Saturn's *Moons*, when we know ſo little of *our own?* For altho' ſome men of Genius have not only diſcovered

"Rivers and Mountains on her ſpotty Globe,"

but have travelled over the whole Hemiſphere which is obverted to us, (And why is the ſame Hemiſphere always obverted? What reaſon can be aſſigned, why we do not ſee the other Hemiſphere in its turn?) have marked out all her Seas and Continents, with the utmoſt Exactneſs: Yea, and carried Selenography to ſo great Perfection, as to give us a complete Map of the Moon: Yet do others (and not without Reaſon) doubt, Whether She has any Atmoſphere. And if ſhe has not, She can have no Rain or Dews, nor conſequently either Seas or Rivers. So that after all we have nothing more than mere Conjectures, concerning the neareſt of all the *heavenly Bodies*.

And what is it that contains them all in their Orbits, and that is the Principle of their *Motions?* By what created Power, what outward or inward Force, are they thrown forward to ſuch a point, and then brought back again to a determinate Diſtance from the Central Fire? Dr. *Rogers* has evidently demonſtrated, that no Conjunction of the Centrifugal and Centripetal Force, can poſſibly account for this, or ever cauſe any Body to move in an Ellipſis. Will *Light* moving outward and returning inward in the form of *Spirit*, account for them?

Nay, if they take away ſome, they plunge us into other Difficulties, no leſs conſiderable. So that there is reaſon to fear, that even the *Newtonian*, yea and *Hutchinſonian* Syſtem, however plauſible and ingenious, and whatever advantage they may have in ſeveral particulars, are yet no more capable of ſolid convincing Proof, than the *Ptolemaic*, or *Carteſian*.

BUT let us come to the things that are nearer home, and ſee what Knowledge we have of Them. And how much do we know of that wonderful Body, that enables us to ſee and know all things round us? I mean *Light*. How is it communicated to us? Does it flow in a lucid River, in a continued Stream from the Orb of the Sun to the Earth? Or does the Sun impel thoſe Particles only, which are contiguous to his Orb, which impel others, and ſo on and on, to the Extremity of his Syſtem? Again, Are the Particles of Light, naturally and *eſſentially lucid?* Or only by accident, when they are collected? Or when put into motion? Yet again, Does Light *gravitate* or not? Does it *attract* other Bodies or *repel* them? Is it the ſtrongeſt, or the only Repellent in Nature, and what communicates that Power to all Repellents in Nature? Is this Power the ſame with Elaſticity, or wherein does it differ therefrom? Is Light ſubject to the *General Laws*, which obtain in all other Matter? Or is it a Body *ſui generis*, altogether different from all other Bodies? Is it the ſame, or how does it differ from *Ether?* Sir Iſaac Newton's *ſubtle Matter?* What is Ether? Wherein does it differ from the *Electric Fluid?* Who can explain (and demonſtrate the truth of his Explanation) the Phænomena of Electricity? Why do ſome Subſtances *conduct* the Electric Matter, and others arreſt its Courſe? Why do a Globe of Glaſs and another of Sulphur, juſt counter-act each other? Why is the coated Phial capable of being charged juſt to ſuch a point, and no farther? *O Crux Philoſophorum!* Superabundant Proof of the Shortneſs of Human *Knowledge!*

BUT let us conſider what is not of ſo ſubtle a Nature, nor therefore ſo liable to elude our Enquires. Surely we underſtand the *Air* we breathe, and which encompaſſes us on every ſide. By its *Elaſticity* it ſeems to be the Grand Mover and General Spring of all ſublunary Nature. But is Elaſticity eſſential to Air, and conſequently inſeparable from it? Not ſo. It has been lately proved by numberleſs Experiments, That it may be *fixt*, diveſted of its Elaſticity, and *generated*, reſtored to it anew. Therefore Elaſticity is not eſſential to Air, any more than Fluidity is to Water. Is it then elaſtic any otherwiſe than as it is joined to another Body? As every Particle of Air, is in its ordinary State, attached to a Particle of Ether or Electric Fire? Does it not derive its whole Elaſticity from this, (Perhaps the only true, eſſential Elaſtic in nature:) And conſequently, when ſeparated from this, loſe all its elaſtic Force: For want of which it is then effete, and will neither ſuſtain Flame, nor the Life of Animals.

By what Power do the Dew, the Rain, the other Vapours, riſe and fall in the Air? Can we account for all the Phænomena of them, upon the Common Principles? And can we demonſtrate, that this is the true, the moſt rational Way of accounting for them? Or ſhall we ſay, with a late ingenious Writer, That thoſe Principles are utterly inſufficient? And that they cannot be accounted for at all, but upon the Principles of Electricity?

Do we throughly underſtand the Nature and Properties of the *Atmoſphere* that ſurrounds us? That immenſe Congeries, not only of Air and Vapours, whether of a Watry or Inflammable Nature, but likewiſe of Effluvia of every kind, which are continually ſteaming out from ſolid as well as fluid Bodies, in all Parts of the terraqueous Globe? Do all Inſtruments, with all the Improvements of them ſuffice, to give us a thorough Knowledge of its conſtituent Parts? Do they inform us of their innumerable Combinations and Changes, with the remote and immediate Cauſes of them? Very far from it: And yet it is not a barely curious Knowledge, but uſeful in the higheſt degree: Seeing for want of it, not only various Diſeaſes, but often Death itſelf enſues.

Let us deſcend to what is of a ſtill more firm and ſtable nature, and ſubject to the Scrutiny of all our

Senſes: Namely the *Earth* we tread upon, and which GOD hath peculiarly given to the children of men. Do the Children of men underſtand this? Of what Parts then is it compoſed? I ſpeak now of its Internal Parts, in compariſon of which the Surface is next to nothing. Many Arguments induce us to believe that the Earth is between Seven and Eight thouſand miles in diameter. How much of this do we know? Perhaps ſome Cavities, Natural or Artificial, which have been examined by men, deſcend One, or even Two Miles beneath its Surface. But what lies beneath theſe? Beneath the region of Foſſils, of Stones, Metals and Minerals? Theſe being only a thin, exterior Cruſt. Whereof conſiſt the Inner Parts of the Globe? Of a *Nucleus,* (as an eminent Man ſuppoſes, in order to account for the Variation of the Needle) and a luminous Medium interpoſed, between that and the outer Shell? Or is there a central *Fire,* a grand Reſervoir, which ſupplies all the Burning Mountains: As well as miniſters to the ripening of Gems and Metals, if not of Vegetables alſo? Or is the great Deep ſtill contained in the bowels of the Earth, a central Abyſs of Waters? Who hath ſeen? Who can tell? Who can give any ſolid Satisfaction to a rational Enquirer?

BUT what wonder if we are ignorant of its Internal Nature: For how many Parts are there on the *Surface* of the Globe, which after all the Diſcoveries of later Ages, are ſtill utterly unknown to us? How very little do we know of the Polar Regions, either in *Europe* or *Aſia?* In *Aſia* particularly, where all but the Sea-coaſt, is mere *Terra incognita?* How little do we know of the Inland Parts either of *Afric* or *America?* Either of the Soil, the Climate, the Fruit, the Animals, or the Human Inhabitants. So far are we from having any proper Knowledge of theſe, that we can ſcarce form any rational Conjecture about them.

AND who knows what is contained in the broad *Sea,* in the Abyſs that covers ſo large a Part of the Globe? Many indeed *go down to the ſea in ſhips, and occupy their buſineſs in the great waters.* But what know they, of what is contained therein; either of its Animal-inhabitants,

tants, its Productions of the Vegetable kind, or thoſe of a Mineral or Metallic Nature? Moſt of its Chambers are inacceſſible to Man, ſo that how they are furniſhed we know not. Leviathan may *take his paſtime therein*: but they are not deſigned for the children of men.

But let us come nearer home. How little do we know even of the Furniture of the Dry Land? Survey thoſe things which fall directly under our notice, even the moſt ſimple, *Stones*, *Metals*, *Minerals*. How exceeding imperfectly are we acquainted, with their Nature and Properties? What is there in the inward Conſtitution of *Metals*, which diſtinguiſhes them from all other Foſſils? From Stones in particular? "Why, they are heavier." True; but what makes them heavier? I doubt, whether *Solomon* himſelf was able to aſſign the Reaſon. What is the original, internal Difference between *Gold* and *Silver*, or between *Tin* and *Lead*? 'Tis all myſtery to the Sons of Men. And yet vain man would be wiſe.

"If all the men in the world, ſays the great Mr. *Boyle*, were to ſpend their whole Life in the Search, they would not be able to find out all the Properties of that ſingle Mineral, *Antimony*." And if all men could know ſo little of one thing, how little can one man know of All?

Let us proceed to the higher Parts of the Creation. Obſerve the *vegetable* Kingdom. And here alſo whatever diſplays the Wiſdom of the Creator, diſcovers the Ignorance of his Creature. Who can clearly determine even that fundamental Queſtion, concerning the General Nature of Vegetables, Does the Sap perform a regular Circulation thro' their Veſſels or not? How plauſible Arguments have been brought, both on the one ſide and the other? Who knows the ſeveral *Species* of Vegetables, from the Cedar of *Lebanon*, to the Hyſſop on the wall? Or rather, (if we would deſcend from the higheſt to the loweſt) to the innumerable Grove of Plants which appear, in the form of Mouldineſs: Or thoſe more innumerable (if the Expreſſion may be allowed) which do not appear to the naked eye at all? Who is able to diſcover the proper, ſpecific Difference, between any one kind of Plant and another? Or the peculiar internal Conformation and Diſpoſition of their component Particles? Yea what man upon earth throughly underſtands the Nature and Properties of any one Plant under Heaven?

ASCEND we higher ſtill, from Plants to *Animals*. But here we are ſtopped in the mid-way. Under which of theſe ſhall we place the innumerable Tribes of Microſcopic *Animals*, ſo called? Are they *real* Animals in the common Senſe of the Word? Or are they Animals, in quite another Senſe? Eſſentially different from all other Species of Animals in the Univerſe: As neither requiring any Food to ſuſtain them, nor generating or being generated? Are they no Animals at all, (according to the Suppoſition of a late ingenious Writer,) but merely inanimate Particles of Matter, in a State of Fermentation? So much may be ſaid for each of theſe Opinions, that it is not eaſy to fix upon any of them.

IF they are Animals of a peculiar kind, which neither generate, nor are generated, they ſpread a veil over one conſiderable Branch of Human Ignorance. For how totally ignorant are the moſt ſagacious of men, touching the whole Affair of *Generation?* I do not ſay, of the Generation of Inſects and Fiſhes: The countleſs Fry,

"That by unnumbered Millions multiply:"

But let us come to that of the moſt perfect Animals, Yea, of Man himſelf. *In* the *book* of the Creator indeed, *were all our members written*; *which day by day were faſhioned, when as yet there were none of them.* But by what Rule were they faſhioned? In what manner? By what Degrees, from the moment of Impregnation? Who can explain

"How the dim Speck of Entity began
"T'extend its recent Form, and ſwell to Man?

By what means was the firſt *Motion* communicated to the *Punctum ſaliens?* When and how was the immortal Spirit added to the maſs of ſenſeleſs Clay? There is no need of deſcending to Particulars: for 'tis Myſtery all! And after all our reſearches, we can only ſay, *I am fearfully and wonderfully made!*

But is there any ſuch thing as *equivocal Generation*, whether of Plants or Animals? It is impoſſible, any thing can appear more abſurd to the eye of Reaſon. Was there ever an inſtance, ſince the World began, that an Houſe grew *of itſelf?* Nay, ſo much as a Bed, a Table, a Chair, or the ſmalleſt piece of Houſhold-furniture? And yet how trifling and inartificial is the Conſtruction of theſe, to that of the meanneſt Plant or Animal? What is the Workmanſhip of *White-hall* or *Weſtminſter Abby*, to that of a Tree or a Fly? And yet, on the other hand, if we deny ſpontaneous Generation, what Difficulties ſurround us? If we can give a plauſible account of the Propagation of Miſſeltoe on Trees, and a few of the Plants growing on the tops of Houſes, or on the Walls of Churches and Towers, yet how many more confound all our Sagacity? And how many Animals are diſcovered in ſuch Places, as no Animal of that kind ever frequented?

With regard to the loweſt Claſs of Animals, *Inſects*, almoſt innumerable are the Diſcoveries which have been made within few Years, particularly by the ingenious and indefatigable Mr. *Reaumur:* But how inconſiderable is all this, in compariſon of that which ſtill remains undiſcovered? How many *Species*, how many entire *Genera* of theſe, are we totally unacquainted with? How many Millions by their extreme Minuteneſs elude our moſt careful Enquiries? And the minuter Parts of larger Animals, eſcape our utmoſt Diligence? So that all we can attain to is an imperfect Knowledge of what is obvious in their Compoſition.

Have we a more perfect Knowledge of *Fiſhes* than of Inſects? How many of the Inhabitants of the Waters, are intirely concealed from human View; by the Element wherein they live? It is not permitted to the Sons of men, to *walk thro' the Paths of the ſea*, nor conſequently to trace out their ſeveral Kinds or Species with any Exactneſs. But it is highly probable theſe are far more numerous, than the Species of Land-Animals: As the Diſtance between the ſmalleſt and the largeſt of Sea-Animals, is ſo immenſely greater; from the *Minow*, for inſtance, (tho' this is far from being the leaſt) to the *Norwegian Whale*: To ſay nothing of Biſhop *Pontoppidan's Craken* and *Sea-Serpent*, which I doubt never exiſted but in his own Imagination. And with regard to the Species we are acquainted with, how little is it that we know? Only a few of their General Properties; enough to ſatisfy our Need, but not our Curioſity.

We are ſomething better acquainted with the Inhabitants of the Air; *Birds* being more acceſſible to us: Yet upon the whole, we are very far from being perfectly acquainted with them. Of many we know little more than the outward Shape. We know a few of the obvious Properties of others, but the inward, ſpecific Difference of very few. We have a thorough adequate Knowledge of none.

"However we have a more extenſive Knowledge of *Beaſts*, many of which are our domeſtic Companions." Certainly we have. And yet a thouſand Queſtions may be aſked even concerning theſe, which we are in no wiſe able to anſwer. To touch only on two or three General Heads. Do they *reaſon*, or do they not? Whence ariſe the different *Qualities* and *Tempers*, not only in different Kinds and Species, but even in the Individuals of one Species, as in Dogs, Cats and Horſes? Are they *mere Machines?* If we aſſert they are, it inevitably follows, that they neither *ſee*, nor *hear*, nor *ſmell*, nor *feel*. For of this mere Machines are utterly incapable. Much leſs can they *know* or *remember* any thing, or *move* any otherwiſe than they are impelled. But all this, as numberleſs Experiments ſhew, is quite contrary to matter of fact. On the other hand if they are not mere Machines, if they have either a Senſation, or Knowledge, or Memory, or a Principle of Self-motion, then they are nor mere Matter; they have in them an immaterial Principle. But of what kind? Will it die with the Body, or not? Is it Mortal or Immortal? Here again we are got into an unknown Path. We cannot order our Speech, by reaſon of Darkneſs.

BUT altho' we know ſo little either of the things that are above us, of thoſe that are beneath us, or of thoſe that ſurround us on every ſide, yet it is to be hoped, we know *ourſelves*: And of all, this is the moſt uſeful, the moſt neceſſary Knowledge. But do we truly know Ourſelves? Do we know the moſt excellent Part of ourſelves, our own *Soul?* That it is a Spirit, we know. But what is a Spirit? Here again we are at a full ſtop. And *where is* the Soul *lodged?* In the Pineal Gland? The whole Brain? In the Heart? The Blood? In any ſingle Part of the Body? Or is it (if any one can underſtand thoſe Terms) All in All, and All in every Part? How is it *united* to the Body? What is the ſecret Chain, what the Bands that couple them together? Can the wiſeſt of Men give a ſatisfactory Anſwer even to theſe few plain Queſtions.

As to the *Body*, we glory in having attained abundantly more Knowledge than the Antients. By our Glaſſes we have diſcovered very many things, which we ſuppoſe they were wholly unacquainted with. But have we diſcovered, why we perſpire three Parts in four leſs when we ſweat than when we do not? What a total Miſtake is it then to ſuppoſe Sweat is only an Increaſe of Inſenſible Perſpiration! Have we diſcovered, Why one Part of Mankind have black Skins, and the other white? It is not owing to the Climate: For both Black men and White are born in the ſame Latitude. And have not Negros the ſame Fleſh and Blood with us? But what is *Fleſh?* That of the Muſcles in particular? Are the Fibres out of which it is woven, of a determinate Size? So that when you have divided them into ſmaller and ſmaller, to a certain point, you come to thoſe of the ſmalleſt kind! Or are they reſolvible (at leaſt in their own nature) into ſmaller and ſmaller *in infinitum?* How does a *Muſcle act?* If you ſay, by being inflated, and conſequently ſhortned: I aſk again, But what is it inflated with? If with Blood, how and whence comes that Blood? And what becomes of that Blood, whither does it go, the moment the Muſcle is relaxed? What is *Blood?* Of how many ſorts of Particles does it eſſentially conſiſt? Of red Globules and Serum? But in the famous Inſtance, the Man bled at the Noſe, 'till what was diſcharged had no Redneſs left. By what Force is the Circulation of the Blood performed? Can any one ſuppoſe the Force of the Heart, is ſufficient to overcome the Reſiſtance of all the Arteries? Are the *Nerves* pervious or ſolid? How do they act? By Vibration, or Tranſmiſſion of the Animal Spirits? What are the Animal Spirits? If they have any being, are they of the nature of Blood or Ether? What is *Sleep?* Wherein does it conſiſt? We do not enquire What are the Effects of it, (Ceſſation of voluntary Motion and ſo on) but what is the thing itſelf, the Cauſe of theſe Effects? What is *Dreaming?* By what Criterion can we diſtinguiſh Dreams from waking Thoughts? I mean, by what means may a dreaming Perſon, then know that he is in a dream? What is (the *Conſanguineus Somni) Death? When* do we die? You ſay, " when the Soul leaves the Body." This cannot be denied. But my Queſtion is, When does the Soul leave the Body? When we ceaſe to breathe, according to the Maxim, *Nullus Spiritus, nulla vita?* This will not hold: for many have revived, after Reſpiration was utterly ceaſed. When the Circulation of the Blood ſtops? Nay, neither will this hold: For many have recovered, after the Pulſe was quite gone. When the vital Warmth ceaſes, and the Juices loſe their Fluidity? Even this is not a certain Mark. For ſome have revived, after the Body was quite cold and ſtiff: A caſe not uncommon in *Sweden.* By what token then can we ſurely know? It ſeems, none ſuch can be found. GOD knows when the Spirit returns to Him. And the Spirit itſelf: But none that dwells in a Body.

WHAT cauſe have we then to adore the Wiſdom of GOD, who has ſo exactly proportioned our Knowledge to our State? We may know whatever is needful for Life or Godlineſs, whatever is neceſſary either for our preſent or eternal Happineſs. But how little beſide can the moſt penetrating Genius know with any Certainty? Such pains, ſo to ſpeak, hath GOD taken, to *hide pride from man!* And to bound his thoughts within that Channel of Knowledge, wherein he already finds eternal Life!

G.R. III. BR. MUS.

FINIS.

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